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SURVEY OF ARCHAEOLOGICAL SITES ON MOTUTAPU ISLAND

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Abstract. A survey of Motutapu Island revealed evidence of 74 sites of prehistoric Polynesian occupation. These are classified tentatively on the basis of visible surface features, and the nature of the occupation is discussed.

Motutapu is a fertile, undulating island, situated in the Hauraki Gulf immediately north-east of Rangitoto, to which it is at present joined by a causeway. The island has an area of 3,700 acres (1497 ha), and reaches a highest point of 398 feet (121 m) above sea level, although much of the central part of the island is higher than 300 feet (91 m).

Geologically, Motutapu is composed of two different formations. The northern and eastern parts of the island are formed by the ancient greywacke which also underlies much of Motuihe, Rakino, Waiheke, Ponui, and some eastern parts of Auckland such as Bucklands Beach and Kawakawa Bay. The southern and western portions of the island are composed of the tertiary Waitemata series familiar in parts of mainland Auckland. The western coast of Motutapu, particularly, is characterised by cliffs of the Waitemata formation (Searle 1964, p. 50).

Motutapu is unique in that almost the entire island is blanketed by fine basaltic ash, erupted from Rangitoto in comparatively recent times. A fertile soil has developed on this ash. Two radiocarbon dates show that the eruption probably took place about 1200 A.D. (Brothers and Golson 1959, pp. 573-574), at a time when human occupation had already begun (Scott, following report). The eruption would have been a catastrophic event, which interrupted human occupation, and for a time rendered the island uninhabitable. The fertile soil which developed on the ash, however, attracted renewed occupation as the large number of archaeological sites on the island testifies.

The island was acquired by Europeans in the 1850s from remnants of Ngati Paoa and allied tribes who formerly occupied many of the Hauraki Gulf islands. Few traditions relating to it are known. It was farmed privately until the Second World War when the entire island was taken over by the Government as a defence area. Since the war, the island has been farmed by the Lands and Survey Department as an experimental farm, and has remained largely closed to the public (Maddock 1966). It has now been added to the Hauraki Gulf Maritime Park but, at the time of writing, only beach areas are normally accessible to the public.

The island has several features which make it particularly attractive to archaeologists. Its predominantly rural character has led to the preservation of numerous small archaeological sites of a kind that is now rare to nonexistent in the

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Auckland Metropolitan area. Although some sites have been damaged by army works and others by modern farming development, the survival rate is still high compared with adjacent mainland areas. The island is large enough, and has sufficient permanently flowing streams, to have supported more than transient camping occupations in the past, but small enough for a fairly thorough survey of all surviving archaeological sites to be possible. The ubiquitous presence of the Rangitoto ash shower, dating near the commencement of the human occupation sequence, provides a recognisable horizon in archaeological sites. Finally, Motutapu's inaccessibility in recent times combined with its proximity to Auckland City, makes it an ideal location for investigating aspects of Auckland's prehistory.

ARCHAEOLOGICAL EXCAVATIONS

Three separate excavations have been carried out on Motutapu, as well as a site survey, making it one of the most intensively studied areas in the Auckland province.

The first excavation on the island was that by Golson and members of the Auckland University Archaeological Society at Pig Bay (N38/21) in 1958 and 1959. This was sufficient to establish the importance of Motutapu as a research area. Preliminary reports indicate the range of material available (Golson and Brothers 1959; Golson 1959, pp. 45-46).

The next excavation was that of a second beach midden site, the Sunde site (N38/24), discovered at the time of the Pig Bay excavation. This site was partially excavated in 1963 and is reported in a following paper.

The most recent investigation was the simultaneous excavation in 1967-68 of two undefended ridge occupation sites, of a type frequently encountered in the site survey. Excavations at both these sites are described in this volume.

SITE SURVEY

During the early part of 1963, intensive field recording was undertaken on the island by members of the Auckland University Archaeological Society, directed by a Site Recording sub-Committee consisting of the writer, Miss A. Leahy and Mrs. M. Hougaard (then Miss M. Nicholls). The survey of Motutapu was part of a programme which endeavoured to combine the recording of sites on the offshore islands, begun the previous year on Ponui (Davidson 1963), with training in site recording techniques for interested members of the Archaeological Society. The methods employed in recording and the inexperience of many people taking part led to some inaccuracies and incompleteness of coverage which are discussed below; nevertheless it is believed a high percentage of existing sites were located, and briefly recorded on the standard forms used in the N.Z. Archaeological Association's site recording scheme. A similar coverage was achieved for the adjacent islands of Motuihe, Rakino, and the western end of Waiheke. Further sites have since been added by individual recorders and the coverage has been extended (in 1967) to include Brown's Island. All sites recorded are now on record in the New Zealand Archaeological Association's files.

The survey of Motutapu was carried out by small groups equipped with 1: 25,000 topographical maps of the island and, in some cases, tapes and compasses. Each group covered a pre-assigned territory. Little use was made of aerial photographs, as the majority of sites do not show well on them. Sites were recorded by written descriptions, and by elementary mapping techniques, including pacing, and compass and tape survey. No sites were mapped by more accurate means with the exception of N38/24 and N38/21, which were mapped during excavation.

The weaknesses of this type of survey are several. A few sites may have been missed, particularly on the eastern side of the island, either because some parties could not cover every ridge in the time available, or through the failure of inexperienced members to recognise fainter indications of pits and/or terraces. The former applies principally to the northern and eastern portions of the island and was largely remedied by further exploration during 1967-68. The latter may be adduced as a possible explanation for the relative paucity of sites in the southern and central portions of the island[1]. Further weaknesses are apparent in the quality of the recording. Some sites were not accurately located, particularly the inland ones. More serious is the fact that the exact dimensions of sites and number of features were not recorded in sufficient detail to permit any detailed analysis. This is particularly true of the largest sites. Thus only general statements can be made about site size. It must be said, however, that some sites are so poorly defined by surface features that any analysis based on surface measurements could be misleading.

All the sites recorded are shown on Fig. 1. It can be seen that the majority are fairly close to the sea and, on available evidence, the central ridges were largely unoccupied. Most sites are near fresh water, and beaches where canoes could safely land.

The sites were recorded on the basis of observable surface features, and members participating in the survey were instructed not to describe sites according to presumed functional categories. In the discussion which follows, therefore, sites are grouped according to a general classification based on surface evidence. Such a classification may be meaningless, if not actually misleading, when we come to describe prehistoric life on Motutapu: in the initial stages of a site survey, however, there are good reasons for avoiding functional interpretations of visible features.

Following the general guidelines available for site surveys in New Zealand at the time (see for instance Golson and Green 1958), sites were divided into three main groups as follows: 1) sites with recognisable defensive earthworks; 2) sites on which earthworking in the form of pits or terraces was visible, but which lacked visible defences; 3) sites in which the only recorded evidence of human activity consisted of midden or refuse deposits. The sites are discussed below under these headings.

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[1] Since this paper went to press, two additional sites have been reported in the south-east part of Motutapu, on the coast between sites N38/50 and N42/142 (Fig. 1). There is a headland pa at Otahuhu Point and a small undefended site consisting of several terraces on the next ridge to the north.

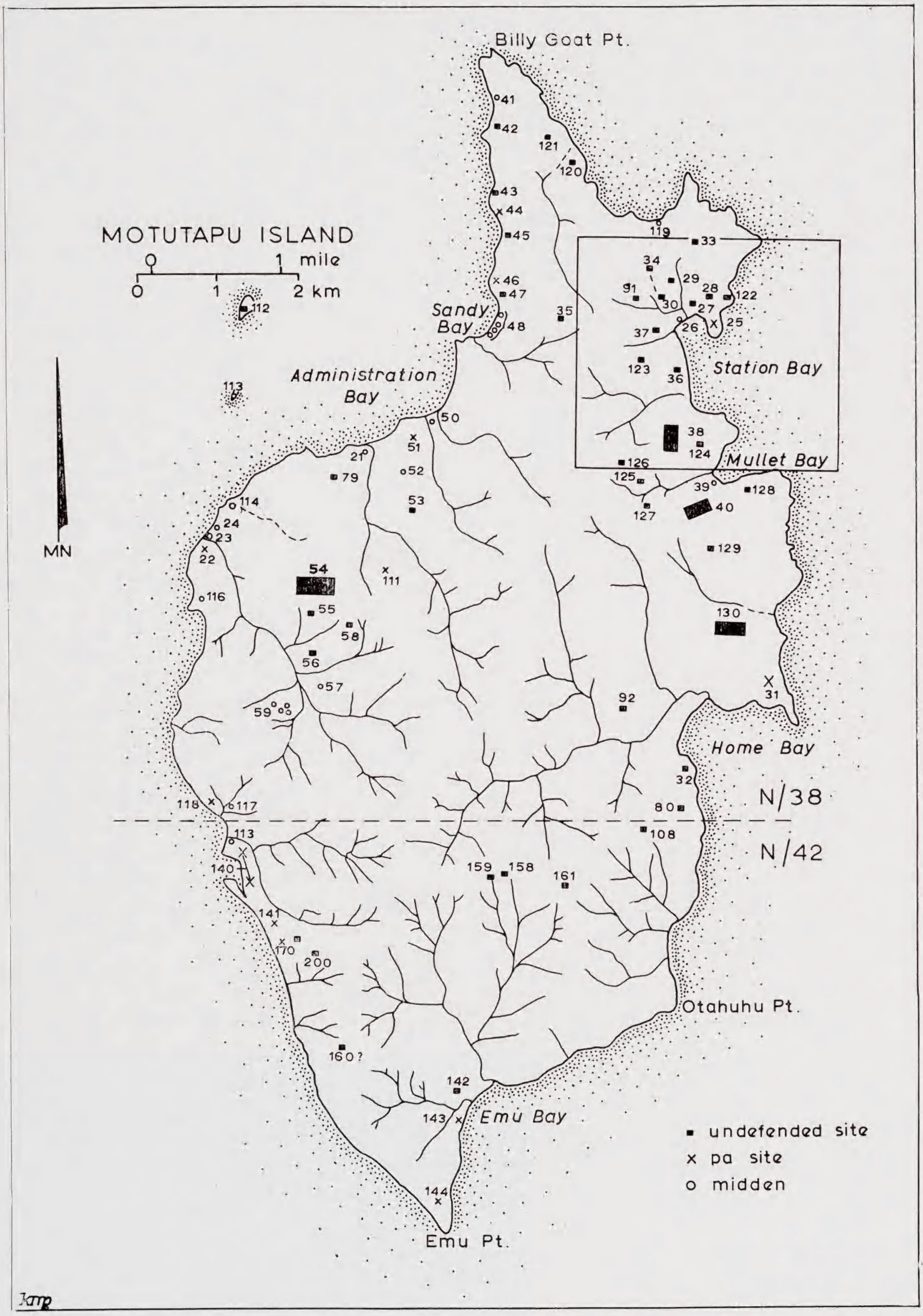

Fig. 1. Distribution of recorded sites on Motutapu Island.

Fortified Sites (Pa)

Thirteen sites in this category have been recorded. With one exception, they are all on the coast; a pattern that has been observed also on Ponui Island (Davidson 1963). In topographical terms they can be described either as headland or cliff edge pa (Golson 1957) but, in fact, most coastal situations that offered defensive possibilities were utilised, and the choice of situation was probably dictated by strategic rather than topographical requirements. The two most impressive pa are N38/31 and N38/25, both on headlands commanding good views of the channel between Motutapu and Waiheke, and guarding two sheltered bays, Station Bay and Home Bay, with their stream valleys and undefended sites (Fig. 2). Both pa are defended by deep transverse ditches and have scarped and terraced interiors. Surface pits are visible within the defended area of N38/31, while there is a group of pits immediately outside the ditch at N38/25. Five more "headland" pa are dotted

Fig. 2. N38/25, fortified headland at Station Bay, Motutapu.

around the western coast between Billy Goat Point and the Rangitoto causeway. Surface pits are visible on N38/44 and N38/46, while all show some signs of internal terracing and midden deposits. In the southern part of the island, along the raised cliffs of Waitemata sandstone, "cliff-edge" pa occur. These utilise the cliff as one lateral defence, and feature two or more transverse ditches and a lateral ditch or terrace on the inland side. Unfortunately, all these sites seem to have been partially filled in by cultivations, and none is sufficiently well preserved for the presence or absence of pits, for instance, to be confidently recorded. N42/140, 141 and 143 seem to have been of this type, while N42/170 was probably also similar. N42/144 is represented only by the remnant of a trench. It may have been either a cliff-edge pa, or a very large headland pa.

The only coastal position on the island which by virtue of its natural features and location might be expected to be fortified, but where no site was found, is Billy Goat Point, which is heavily modified by World War II fortifications. If there was a prehistoric pa here, no evidence of it remains.

One site does not conform to the coastal headland/cliff-edge pattern exhibited by the others. N38/111 is a rounded hill top defended by a rectangular earthwork which is in places definitely a ditch, at others merely a scarp and terrace.

Most, if not all of these pa have at least some associated midden remains. Two were recorded as having surface evidence of more than one occupation, and it seems likely that excavation would reveal successive occupations on most or all of them. N38/25 has surface evidence of an earlier, and partially infilled ditch immediately outside the present deep ditch. At N38/44 an eroding face revealed completely filled pits, in addition to pits which were visible on the surface, implying earlier and later phases of pit building on this site.

Undefended Pit and/or Terrace Sites

The most common form of field evidence on Motutapu Island is the man-modified area of ridge or hill top which lacks earthwork defences. Owing to the preoccupation of New Zealand field archaeologists with fortifications, these tend to be lumped together as "undefended". The 42 sites of this category on Motutapu range from six instances of isolated pits to the three largest sites on the island. All occupy areas of ridge, either on gently sloping spurs or knolls. Some are very close to the sea, others are on spurs abutting into swampy valleys. A fourfold division according to size and complexity has been established but, in fact, there is an almost continuous spectrum from smallest to largest.

large complex undefended sites

N38/54 is undoubtedly the largest prehistoric site on Motutapu Island. It was originally recorded as a pa, but its lack of defensive ditches and the gentle slope of the scarps have led to its reclassification as an undefended site. It is situated in the north-west part of the island on a high round hill which carries a trig at 364 feet (111 m) above sea level. The top of the hill is flat and grassy with no visible surface

features, but on the southern and western slopes a number of large broad terraces are visible. There are a few indistinct terraces on the northern and eastern sides, but these are not continuous, and there is no evidence that the entire circumference of the hill was ever terraced. Many of the terraces carry a heavy deposit of shell midden, sometimes as much as 18″ (46 cm) deep and fairly concentrated. The site commands a fine view of the surrounding countryside and, in so far as the approaches are steep, it may be said to be naturally defended. Its discontinuous nature, however, makes it doubtful that it could be effectively fortified.

Two other large and complex sites were recorded on the island. N38/40 is a hill between two streams running into Mullet Bay. The hilltop and several spurs running down from it to the beach are all modified, in what appears to be a planned arrangement. A rough count on this site indicated at least 11 recognisable pits and 17 terraces, as well as a heavy scatter of shell midden. In this case, the hillside is steep and inland access could have been cut off by a palisade. N38/130 is somewhat similar. It is surrounded on three sides by swamp while on the fourth it is connected to the main ridge system by a low saddle. It is thus almost an island in the swamp. The rounded hilltop is completely landscaped with terraces and/or pits, again set out in such a way that they appear to be the result of a single plan.

Each of these sites, because of its planned arrangement, must be the result of a single extensive occupation, rather than a fortuitous conglomeration of smaller sites of different ages. At some stage during the island's history it was occupied by communities who built settlements as large as, or larger than, any of the recognisable fortified pa; communities moreover who did not surround their settlements with defensive works.

MEDIUM-SIZED UNDEFENDED SITES

Broadly speaking, these are sites in which there is evidence for more than half a dozen pits and/or terraces in planned arrangements. Superficially they are not unlike two undefended sites previously excavated in other areas of the Auckland Province, Skipper's Ridge at Opito (Parker 1960) and N53-54/6 at Kauri Point (Green 1963a). Fourteen sites have been assigned to this category, although there is undoubtedly some overlap with the next group. They are mostly on the ends of spurs, or half way up ridges, although one is on a hill top, and one is on the central ridge in the northern part of the island. Two consist of a series of single pits and/or terraces strung out along a ridge, but the remainder are clusters of features grouped at a point where the terrain is wide enough to permit more than a single row of structures.

In these, as in other undefended sites, it was often impossible to determine whether a feature was a pit or merely a terrace. The surface evidence usually consists of a slight depression, or patch of greener and more luxuriant grass, sometimes accompanied by a strong growth of thistles. One of the objects of the 1967-68 excavations (described in following papers) was to determine whether or not pits were present. Results, however, showed that similar surface evidence may represent either a terrace, or a filled pit.

Several sites in this category were as large as some of the pa. In particular, a strong similarity was apparent between N38/43 and 45, in this category, and the

fortified sites 44 and 46. These four were similar in size and location; the presence of transverse ditches on the latter pair, however, indicate that they were definitely fortified.

Six of the sites in this category were recorded as consisting of pits, terraces and midden. A further two were listed as terraces and midden. No midden was recorded for the remainder, but it is probable that excavations or more careful surface examination would reveal midden.

SMALL UNDEFENDED SITES

Twenty sites were recorded towards the lower end of the size range. These included groups of two, three, or four pits, groups of two, three or four terraces, combinations of one pit and two terraces, or one pit and one terrace, and a single recognisable terrace with a large amount of midden. Many sites had associated midden. Some were situated on steep or narrow ridges, which would not permit larger aggregations, but others were in situations that would apparently accommodate larger clusters without difficulty.

SINGLE PITS

Six instances of single pits were recorded. In all cases it seemed fairly certain that they were indeed isolated pits. No midden was recorded with any of them; this may, however, reflect inadequate recording, rather than an actual absence of midden.

Middens

This, too, is a very broad category in which several different types of site are grouped together. They may be divided for discussion purposes along two different lines, according to whether or not they contain evidence of industrial activity, particularly stone working, and whether they fall into Green's (1963a, p. 147) categories of beach stream middens, or dry land middens.

Eleven middens located on coastal flat areas were recorded. Four of these contain abundant evidence of stone working, while the remainder are characterised predominantly by shellfish remains.

COASTAL WORKING FLOORS

The four principal working floors are located in sandy bays in the north-western portion of the island, at or near stream mouths. N38/23, in the southern portion of Northwestern Bay, was marked by exposures of flakes and shell in the sand. N38/24, on the other side of the stream mouth to N38/23, has been excavated (Scott, following report). It contained layers of occupation above and below the Rangitoto ash. N38/21, at Pig Bay, similar to N38/24, has also been excavated and briefly reported on (Golson and Brothers 1959, Brothers and Golson 1959, Golson 1959). N38/48, at Sandy Bay, is a series of exposures in sand hills along the length of the bay. On all these working floors, the principal industrial activity seems to have

been stone adze making, utilising the local greywacke which outcrops in suitable and accessible forms along this portion of the coast.

OTHER BEACH STREAM MIDDENS

The remaining beach stream middens are located in other flat alluvial areas, where so far no traces of industrial activity have been encountered, and include Station Bay and Mullet Bay, at both of which there is a scatter of shell midden on the flat behind the beach; Administration Bay, where the midden is largely destroyed by the army barracks; the unnamed bay south-east of Billy Goat Point, and the small bay immediately north of N38/23 and 24. N38/116 represents a fairly continuous scatter of midden along a coastal shelf in this area.

Two further beach middens, N38/117 and N42/113 near the Rangitoto causeway, consist of larger and more concentrated shell midden deposits, more resembling the type sometimes interpreted as the result of specialist shellfish collecting activities. These are the only two sites on the island that are considered to belong to this type.

DRY LAND MIDDENS

One dry land midden contained evidence of stone working. N38/41 consisted of shell midden and stone flakes spilling down a steep bank below a flat ridge end. No signs of terraces or pits were observed on the ridge, although the possibility of an undefended site existing here was noted during the survey. The results from excavations at N38/30 (Leahy, this volume) indicate conclusively that stone working was sometimes carried out on undefended sites on the island and it is probable that this was also the case here.

The remaining dry land middens, N38/57, 59 and 52, are in the north-western portion of the island, which is the most heavily affected by Second World War defensive works. All these middens occur in situations where undefended sites might be expected, but have not been recorded. It is quite possible, however, that there are, or were, undefended pits or terraces at these places.

Only two sites remain to be mentioned. These are N38/112, and 113, which consist of midden scatter on the old greywacke stacks which outcrop as islets to the north-west of Administration Bay. N38/113 could have been a small defended position, but only the midden now remains as evidence of occupation.

DISCUSSION

Even though an intensive survey has been carried out on Motutapu and four sites have been partially excavated, we are far from being able to describe in detail the prehistoric occupation sequence. The amount of research required to elucidate the past of this small island should serve as a warning against too hasty, or too sweeping generalisations about the prehistory of the Auckland area, or the Auckland Province.

It is to be hoped that at some future date more detailed information about the vegetation cover and natural resources of Motutapu may be available. As yet, little

attempt has been made to investigate these aspects, which will require the co-operation of scientists from other disciplines.

At present, Motutapu is entirely grassed, with small stands of pohutukawa, *Metrosideros excelsa* Gaertn., karaka,*Corynocarpus laevigatus* J.R. & G. Forst., and tawapou, *Planchonella novo-zelandica* (F. Muell.) Allan, in only a few places. Apparently the island was not covered with coastal forest in early European times. Possibly the Rangitoto ash shower inhibited succession towards coastal forest; more probably, the Polynesian occupants kept parts of the island clear.

The range of birds recovered from the early level of N38/24 provides some indication of the fauna exploited by the earliest occupants (Scott, this volume). Bird remains are largely absent from post-eruption deposits, suggesting that Motutapu did not support large populations of land birds following the ash shower. At the present time, Motutapu has a substantial population of pukeko and one or two pairs of hawks; in the past, these and other land birds would have been reduced rapidly by Polynesian occupants, leaving only the sea birds.

Today, the coasts offer a limited range of rocky shore shellfish, notably rock oysters, with substantial numbers of sand or mudflat species only at Islington Bay. In general, the shellfish available would not attract people with the resources of the East Coast Bays, and the Tamaki Estuary at their disposal. The island would, however, be well placed for fishing.

Motutapu is large enough to have supported a small permanent population in Polynesian times; whether or not it did so, however, cannot yet be determined. The greatest difficulty in interpreting both excavation and survey data in the Auckland area arises from our lack of knowledge of the extent to which Polynesian inhabitants ranged over a wide area in pre-European times. For the Auckland area neither traditional nor historical evidence offers much assistance, beyond a general impression of considerable mobility.

We cannot therefore consider the evidence from Motutapu without reference to neighbouring areas, tempting though it may be to view Motutapu as a discrete area. The possibility that Motutapu was just one element to be exploited by people ranging over a larger and more varied territory must constantly be held in view. Until more excavation results are available from surrounding areas, it will be impossible to control this aspect of interpretation with any certainty.

The sites on Motutapu themselves, however, provide some indication of what the island was used for, and what it was not used for. Even though the time element is as yet poorly controlled, some indication of the function of the sites is possible.

The earliest sites at present known are the Archaic working floor areas N38/21 and 24. The lowest level of the latter site shows it to have been first occupied as a camp site at which fish, shellfish, and birds were consumed, and at which the locally outcropping greywacke was first worked. The use of the sites continued, however, for a considerable period after the Rangitoto eruption. If Golson's interpretation of the Pig Bay site is correct, indeed, the greywacke outcrops continued to be used for the manufacture of Archaic adzes until the 17th century (Golson 1959, p. 46).

Green's interpretation would place the working floor component at Pig Bay at some unknown earlier period (1963b, p. 54). The depth of deposit at both excavated sites, however, suggests use of the greywacke long after the eruption even if not as late as the 17th century.

The first known occupation of Motutapu, then, was a camping occupation, during which the occupants lived on local fauna, and exploited local rocks for adzes. Sites of this nature cluster on the north-west coast where the most suitable greywacke outcrops occur.

It might be expected that a continuing use of the island would be as a base for fishing parties. Only a few sites have so far been found, however, which contain evidence of this. These are clustered around Islington Bay, and are surprisingly absent from the sheltered anchorages of Station, Mullet and Home Bays, although more intensive exploration of these areas might reveal new evidence. Otherwise coastal midden remains are scattered and non-concentrated.

There is no doubt that the majority of sites on Motutapu are clusters of pits and terraces, only a minority of which show visible signs of defence, but most of which at least have some associated midden remains. The question of interpreting these sites will be discussed in greater detail in succeeding papers; it will be argued that many of them were used both for residential and for food storage purposes.

With complete lack of time control, it is difficult to discuss the possible settlement pattern at various times other than in most general terms. It can be said, however, that the three largest sites on the island are larger than the pa. If the occupants of these large sites were engaged in seasonal or peacetime activities with a fortified pa somewhere in the background to retreat to, their pa must have been one of the large Auckland cones.

Similarly, the medium-sized sites tend to be of comparable size to the pa on the island and in some cases it is difficult to escape the conclusion that at least some of the pa, particularly those in the north-west of the island, were similar in every respect to unfortified sites, and must have been fortified merely in response to an immediate need.

Only the small undefended sites, and the isolated pit sites can be interpreted as the result of the separate activity of a single domestic group, who presumably belonged to a larger community with a larger communal site somewhere else.

Obviously, a great deal more needs to be discovered about these sites before their full history, and that of Motutapu as part of the greater Auckland area can be understood. Their relative ages, the relationship of defended to undefended, and the extent to which cultural continuity on the island and cultural relationships with mainland areas or other islands can be demonstrated, all require investigation. The evidence of the sites themselves, however, suggests that Motutapu was used primarily for gardening and food storage, throughout much of its history, by people who had to consider defence, but were not primarily concerned with living in fortified pa; and who also exploited the local rock, and participated in fishing activities and shellfish gathering while living on the island.

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EXCAVATIONS AT THE "SUNDE SITE", N38/24, MOTUTAPU ISLAND, NEW ZEALAND

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Abstract. N38/24, a midden at Sandy Cove, Motutapu Island, was excavated in July 1963. Evidence of Polynesian occupation was found above and below the Rangitoto ash (A.D. 1188 ± 50 years).

The scientific study of the prehistory of Motutapu was initiated in 1958 and 1959 when J. Golson directed excavations during two field seasons at Pig Bay. Reports describing the results of the Pig Bay excavations outline the general progress of the work (Golson and Brothers 1959, pp. 5-8), and offer certain preliminary conclusions (Brothers and Golson 1959, pp. 569-77). The excavation of the stratified deposits at Pig Bay revealed an intensive, if not continuous, occupation of the site during the interval A.D. 1208 ± 50 to 1678 ± 40, following the eruption of nearby Rangitoto. Evidence of man's activity during this time was found within a geological sequence of interbedded water-laid ash beds and dune sediments, all overlying an 18 inch (46 cm) thickness of Rangitoto ash. Typological dating of adzes from Pig Bay appeared to place at least part of the site within the Moa Hunter horizon of New Zealand prehistory (Brothers and Golson 1959, p. 576). Finally, the presence of a piece of worked greywacke from beneath the Rangitoto ash at Pig Bay "strengthened by similar discoveries reported by Mr. R. Sunde from a beach site on the north-west coast of the island" suggested human occupation on Motutapu prior to the eruption of Rangitoto.

So much was generally recognised but, because a complete analysis of the Pig Bay material was not possible at that time and, more important, because almost no local comparative data were known, only the most tentative conclusions were possible. Thereafter, the question of man's presence on Motutapu prior to the eruption of Rangitoto became increasingly important, particularly when viewed against the broader problem of man's place in general New Zealand culture history. Thus in July 1963, at the suggestion of R. C. Green, Senior Lecturer in Prehistory, University of Auckland, the author, with members of the Auckland University Archaeological Society, began archaeological work on Motutapu. The excavations at Pig Bay had forecast the need for further work on the island, and the report which follows documents the limited, but rewarding, archaeological study of the Sunde site.

THE SETTING

Within Northwestern Bay, on the north-west coast of Motutapu, lies Sandy Cove, a remnant terrace in one of several drowned valleys within the Bay. The general topography of the area will be best understood by an examination of Fig. 1, which gives an adequate idea of the situation of the Sunde site with reference to the

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coastline and the immediately surrounding land. The site, N38/24, discovered ¾ mile (1.2 km) south-west of Pig Bay, lies on the almost level plain of Sandy Cove which is bounded on the north and south by the higher tableland of Motutapu whose further flanks drop precipitously into the ocean. To the east, the land slopes gently upward toward the narrow head of the small valley, and its western boundary is the rapidly eroding beach front where an unknown portion of the archaeological site has already disappeared.

In modern times, the population of Motutapu has been low, the land having been used almost exclusively for farming and sheep raising. The valley bottom, which is cut by a permanent stream, has a good cover of grass with a prominent stand of pohutukawa, *Metrosideros excelsa* Gaertn., immediately to the north.

After the discovery of the site by R. Sunde in 1958, surface collections were made during several subsequent visits (Golson 1959, p. 7). At this time, N38/24 presented a disturbing picture of erosion by wind and wave action. The general area of the midden, which is only slightly higher than the surrounding land, is flat on top, covered effectively by grass, and gives no indication of the strata below. The midden, however, as a result of erosion slopes as a whole in the direction of the ocean, i.e., the direction normally taken by runoff flowing toward the beach. The beach and lower slopes of the midden receive the accumulation of shell and bone washed from above, as well as large blocks of primary ash also weathering out. The special feature of this part of the coastline which attracted Mr. Sunde's attention to the site, is the lenticular patches of human refuse which appear in the interface of ash and beach sand (Fig. 2). Random collections made along the eroding surface of this interface have generally yielded excellent results in the form of avian and mammalian bone as well as implements of stone and bone.

THE INVESTIGATIONS

On July 1, 1963, the writer in company with R. C. Green, visited the site for the purpose of planning the excavations, and field work began the following week. The entire month of July was consumed by this excavation, although field work was possible only during weekends. Members of the Auckland University Archaeological Society were employed as volunteer labourers, both in the field and in the laboratory processing of materials. Because the excavation of N38/24 was conceived as a vital, but necessarily limited operation, the scope of the work called for only six to nine workers during any single digging period.

The field work began in several ways at once. A contoured site map of the Sandy Cove drainage area was started, and several workers were sent to reconnoitre the beach on either side of the excavation area in order to note the location of cultural material beneath other exposures of Rangitoto ash. The position of artifacts and human waste beneath the ash was extremely interesting and a systematic study of this, the deepest cultural deposit known on Motutapu, was the most important objective at the Sunde site. The development of an efficient technique for this task was a matter of experimentation. The procedure first adopted was to cut longitudinally along the outer face of the ash and weaken the resultant narrow block so that it could be lifted out and overturned and examined for waste material usually found

E

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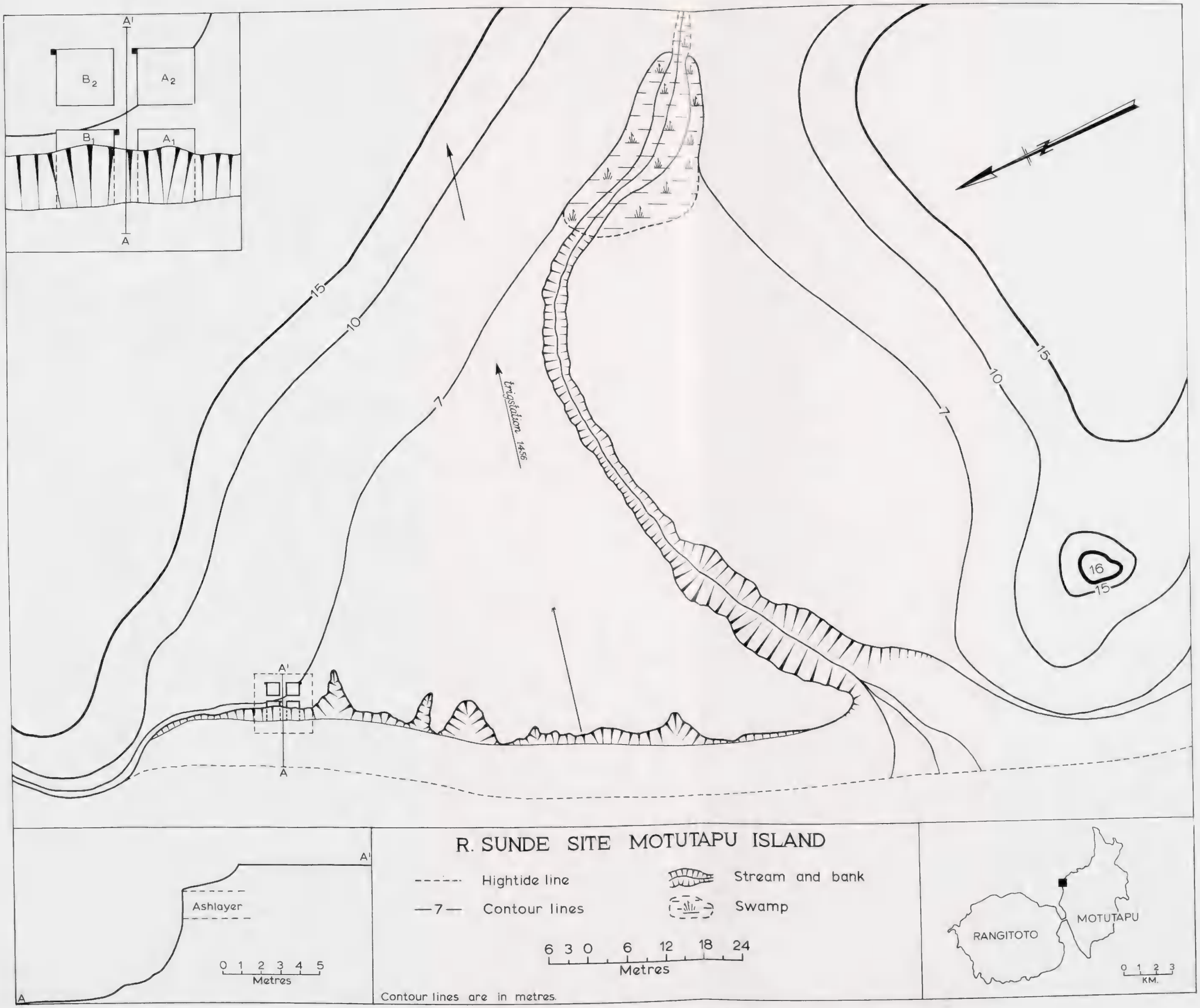

FIG. 1. Plan of "Sunde site", N38/24, Sandy Cove, Motutapu Island.

adhering to the bottom. Because of the thickness and well-compacted consistency of the ash, this method proved to be too laborious. Better success was achieved by excavating beneath the ash to form a tunnel approximately two metres wide, which opened on the seaward side and was continuous with a vertical shaft at its opposite end (Fig. 2). This made it possible not only to collect more rapidly the abundant evidence of man's occupation of the terrace before the eruption of Rangitoto, but to do so in such a way that the sequence of deposition, both cultural and natural, would be better preserved for study.

For the archaeology of the upper soil horizons, the procedure of excavation and notation was essentially unaltered from that used previously by Golson on Motutapu and employed generally for midden archaeology in New Zealand. The actual area for excavation at the Sunde site was selected to coincide with the greatest density of cultural material beneath the ash. Four two-metre squares were dug, leaving one-metre baulks between squares. Ultimately, several baulks were removed to allow a more complete study of the appearance, composition and dip of the succcession of strata. In each of the four squares, the columns were removed in 6 inch (15 cm) arbitrary levels until the natural strata became apparent. The natural strata, which then served as excavation levels, were numbered down from the top, and were found to be the same in all four squares. No grid system was drawn, but the site of excavation was located from benchmark 1 which had itself a known relationship to Trig Station 1456. All vertical measurements were calculated from a datum whose elevation above sea level had been determined by level and stadia rod.

All finds were located by depth level and square number, however, inasmuch as the same natural stratigraphy was found in all four squares, and since the excavation was limited horizontally, no conclusive importance is attached to the horizontal provenance of any artifact. Exceptions noted were *haangi* and other special features such as possible postholes.

Certain compromises in field methodology were necessary owing to the limited time and nature of the excavation. There was a great density of shell and other refuse in the cultural strata and the excavated earth was examined only once for content, from trowel to shovel. All worked stone and worked bone, plus representative collections of shell and faunal material were saved from each level. In addition, three columns, each 15 cm square, were dug adjacent to the main excavation. In each column, the total volume of each level was collected so that the content of each level would be susceptible to direct observation in the laboratory.

At the conclusion of the digging each week, all excavated material was taken to the laboratory. Artifacts and faunal material were numbered according to the catalogue system of the Department of Anthropology, preparatory to identification and analysis. All material from the site was transferred to the permanent collections of the Auckland Institute and Museum in 1968.

Geology

Three distinct lithologies are present in the section of the Sunde site and each will be discussed.

(1) The lowest formation contains sands and numerous bleached fragments of shell: it underlies a distinctive terrace surface, marked by a soil horizon, which stands at 2 m above high water mark. The sands are rich in quartz, feldspar and lithic detritus from the adjacent Tertiary and Mesozoic rocks and they significantly lack basaltic debris typical of the Rangitoto ash. On the landward side of the terrace, and underlying its surface, a small pocket of lacustrine beds consists of fine clays and vegetal remains and represents the margin of a swamp which occupied a shallow depression of the original terrace surface.

(2) Rangitoto ash, averaging 70 cm in thickness, covers the surface of the buried terrace. In mineralogical and textural detail it is identical with that described ¾ mile (1.2 km) to the north-east at Pig Bay by Brothers and Golson (1959, p. 571). Brown shards of basaltic glass are abundant and form the matrix for chips of vesicular basalt and crystal fragments of olivine, pyroxene, plagioclase feldspar, and opaque ores. The ash is massive and the interface against the old terrace surface is clearly defined.

(3) The ash grades upwards into a set of beds, 1.25 m thick, which are varied in character, but which consist mineralogically of ash mixed in varying proportions with normal beach sands. Dune bedding, sometimes topped by a fossil immature soil, indicates periods of wind deposition; horizontally-bedded mixed sands are lake beds formed in dune hollows, or surface wash from the adjoining hill slopes. This uppermost group of beds contains a variety of artifacts.

The overall stratigraphy at the Sunde site is in complete accordance with the sequence at Pig Bay; that is, a set of ash-free sands, covered by Rangitoto ash, which passes upwards into dune and lake sediments with ample evidence of human occupation.

At the Pig Bay locality, N38/21, the ash rests, at modern high-water mark, on a beach sand containing abundant shell fragments. This sand was interpreted as the beach deposit forming the strand line immediately prior to eruption of the Rangitoto ash, for the following reasons:

(1) the sand does not rise above present sea level,

(2) fragments of basalt or basaltic glass are absent from the sand, and

(3) the constituent shell fragments gave a carbon date of A.D. 1208 ± 50 years. Confirmatory evidence was obtained from carbon dating charred twigs, found immediately below the ash, but on top of greywacke soil at the east end of Pig Bay. The date determined was A.D. 1188 ± 50 years (Brothers and Golson 1959, p. 573).

In the Pig Bay area, and elsewhere on Motutapu, there appears to be only one primary Rangitoto ash layer, which is succeeded upwards by wind-blown and water-laid beds containing artifacts and consisting of reworked ash with admixed normal sediments. At Pig Bay, this single ash fall carpeted the landscape and was spread as an 18 inch (46 cm) layer over sands at the head of the beach, and over the neighbouring hills.

At the Sunde site, the same ash layer is two feet (61 cm) in depth, the greater thickness no doubt being a result of closer proximity to the Rangitoto source vent.

Again at this locality, the primary ash bed is overlain by a mixture of reworked ash and other sedimentary detritus enclosing adze flakes, charcoal and fish bones.

There is one feature of particular interest in the stratigraphic section from the Sunde site. The ash has covered and concealed a natural terrace which has its surface at 2 m above modern high tide mark; the shelly sands underlying the terrace are exposed by erosion on the seaward side and were penetrated during excavation of the site. Brothers (1954, pp. 686, 688) commented that recent retreat of the sea from a post-glacial maximum was responsible for beaches and benches 8 to 12 feet (2.4 - 3.7 m) above modern sea level and commonly filling bay-heads, e.g., at Kaipara and Auckland. Schofield (1960, p. 478) studied beach ridges of a chenier plain in the Firth of Thames and obtained radiocarbon dates for samples of shell. The oldest sample was dated 3900 ± 90 years before present, and was from a beach ridge which indicated a former sea level 7 feet (2.1 m) above modern sea level. Schofield concluded (1964, p. 369) that sea level rose above the present about 4,000 years ago.

It follows that the interface between the Rangitoto ash (A.D. 1188 ± 50 years) and the terrace surface which may be 4,000 years old, is a time gap of possibly 3,200 years. The presence of human artifacts on the terrace surface, and below the ash, shows that about A.D. 1188 ± 50 years the terrace was inhabited. From an archaeological viewpoint, the succession at the Sunde site appears to have the following implications:

(1) the adze flakes, adzes, fish bones, etc., that have been excavated from the terrace surface may represent many hundreds of years of human occupation before A.D. 1188 ± 50 years.

(2) artifacts have not, and should not, be found in the sediments forming the terrace since these were deposited possibly 4,000 years ago, and

(3) in view of the extensive time gap at the terrace/ash interface, and the lack of any intermediate deposits between the terrace surface and the ash, attention should be given to any carbon samples that can be obtained from *haangi* cut into the terrace surface; since the Rangitoto ash covers the terrace, such samples could be older than A.D. 1188 ± 50 years and could indicate a minimum length of human occupation in the area.

Stratigraphy

The principal features of the stratigraphy at site N38/24 are shown in Fig. 2. Essentially, there are two cultural zones separated by Rangitoto ash. The section, including soil stratification and cultural content, consists of 12 numbered divisions and may be described as follows:

(1) Level 1, found at the top of the section, is a well-defined zone of black humus of the same composition as level 3, although of slightly darker colour. It contains stone, bone, and shell scattered throughout.

(2) Level 2 is a wind-deposited, non-humic dune sediment of ash and beach sand containing obsidian, shell, bone, and stone, etc.

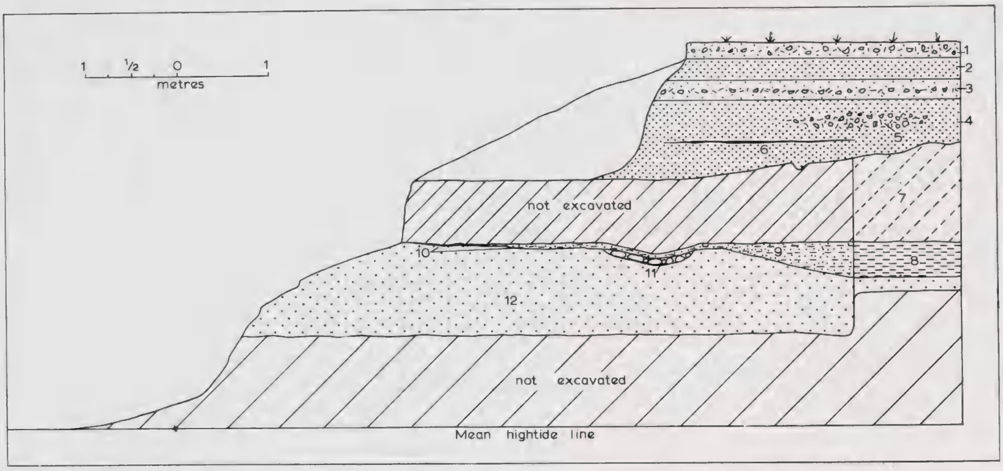

FIG. 2. Cross-section drawing of main excavation, site N38/24, Sandy Cove, Motutapu Island.

(3) Level 3, a rich black humic soil horizon as in level 1, has abundant evidence of human occupancy, in bone, stone, charcoal, etc.

(4) Level 4, as in level 2, is non-humic beach sand and ash, and both are lighter in colour than levels 1 and 3. This, the thickest stratum, was found to be relatively free of shell and stone, etc., throughout the early part of its deposition.

(5) and (6) These do not represent time divisions, but features of man's occupancy during the period of wind deposition marked by level 4. As may be readily seen by reference to Fig. 2, these two features represent: a dense pocket of tightly packed shell and other waste food material (5), and an elongated, thin seam of the same material (6). Both may have been small, local refuse heaps since neither was found to be continuous in the opposite wall of the excavation. A *haangi* was found in close association with (5).

(7) Rangitoto ash. See GEOLOGY for description.

(8) This is a stiff, reddish clay loam containing scattered pebbles, small fragments of bone, and excrement. These clays undoubtedly contain much decomposed organic material, and several well preserved positive leaf impressions from the top of the clay were found on the bottom of the overlying ash (see Cooper, Appendix 1).

(9) A sandy clay loam, representing a continuation of (8), but with an admixture of sand. This deposit grades out into a thin lens of sandy clay and does not appear in the beach profile. No cultural material.

(10) Terrace/ash interface, as described earlier. This can best be thought of as a thin seam of varied faunal remains, plus several implements of bone and stone, deposited on top of unstratified beach sand and buried directly by ash from Rangitoto, i.e., without the interposition of other occupation, either natural or cultural.

(11) This was an approximately circular fireplace, around which sandy clay had been discoloured by burning. A large quantity of charcoal was recovered. Figure 2 illustrates the way in which the falling ash mantled the surface of the terrace and filled the depression created by this *haangi*.

(12) Terrace. See GEOLOGY for description.

At the Sunde site, therefore, five major periods of occupation may be recognised: the period of occupation of the terrace up to the level at which Rangitoto ash fell, followed by the ash itself, and finally, a series of four interbedded, culture-bearing soil horizons alternating between brown dune sands and black fossil soil.

FAUNAL REMAINS

Bone recovered from the site was identified by Mr. R. J. Scarlett of the Canterbury Museum, Christchurch. The species present in each layer, with an indication of the number of individuals, and the number of bones they were represented by, are given in Tables 1 and 2. A wide range of fauna was present in the layers beneath the Rangitoto ash, indicating that the early Polynesian visitors to the island exploited abundant bird life available in the vicinity. Both land and sea birds are well represented, and include the extinct crow and the extinct eagle as well as one moa bone. It is uncertain that moa was actually available on Motutapu, and this bone, and perhaps some other bird bones, may have been brought to the site. In addition to the many bird species, tuatara, fur seal, dog and fish were present in the layers beneath the ash.

Bone identifications from the four layers above the ash are given in Table 2. A very much smaller range of fauna was represented here. No birds at all were found in levels 1 and 2, in which the only bone was dog and fish, the latter in considerable quantity. Fish bone was also abundant in levels 3 and 4, with dog also present. In level 3, two sea birds were present, while several land birds, two sea birds, and fragments of a sea mammal were found in level 4.

The bone remains indicate a steady decrease in the range of species in the site through time, with the two upper levels resembling sites N38/37 and N38/30 (Allo, this volume) in the complete absence of bird and the predominance of fish, with a minor representation of dog. Although small amounts of bird bone are present in levels 3 and 4, these deposits are in marked contrast with the levels beneath the ash, which provide by far the fullest range of species yet known from an archaeological deposit in the Auckland area. The dramatic decrease in bird remains above the Rangitoto ash may be presumed to result both from the effect of the eruption on the surrounding area, and from the presence of man in the vicinity in increasing numbers.

There were 23 species of salt water shellfish found in the site. Their occurrence at each level is illustrated in Table 3, and is meant only as a ready guide to the presence or absence of individual species. The range of shells from beneath the ash is very restricted; a greater variety was present in all the upper levels, where a heavier reliance on sea foods generally, both fish and shellfish, apparently compensated for the much smaller range of birds.

TABLE 1

FAUNAL REMAINS, N38/24

Beneath Ash

MOA

The smallest New Zealand Moa, *Euryapteryx curtus* (Owen), is represented by a nearly complete left tarso-metatarsus.

OTHER BIRDS

Gannet, *Sula bassana serrator* Gray. Two individuals identified from 16 bones.

North Island Kaka, *Nestor meridionalis septentrionalis* Lorenz. A minimum of 14 individuals identified from 96 bones.

Spotted Shag, *Phalacrocorax* (*Stictocarbo*) *punctatus punctatus* (Sparrman). Four individuals identified from 26 bones.

Extinct Crow, *Palaeocorax moriorum* Forbes. One bone.

North Island Weka, *Gallirallus australis greyi* (Buller). Three individuals identified from 15 bones.

Tui, *Prosthemadera novaeseelandiae novaeseelandiae* (Gmelin). Two individuals, one large and one small, were identified from 6 bones.

Extinct New Zealand Eagle, *Harpagornis moorei* von Haast. One bone.

Black-backed Gull, *Larus dominicanus* Lichtenstein. Two individuals identified from 4 bones.

Parakeet, *Cyanoramphus novaezelandiae novaezelandiae* (Sparrman). One bone.

Fluttering Shearwater, *Puffinus gavia* (Forster). This is almost certainly the nominate species as *P. gavia huttoni* hardly ever reaches Auckland. Two individuals identified from 7 bones.

Northern Blue Penguin, *Eudyptula minor novaehollandiae* (Stephens). Two individuals identified from 11 bones.

New Zealand Pigeon, *Hemiphaga novaeseelandiae novaeseelandiae* (Gmelin). Two bones.

Buller's Shearwater, *Puffinus bulleri* Salvin. One bone.

New Zealand Quail, *Coturnix novaezealandiae novaezealandiae* Quoy and Gaimard. Tentatively identified from one bone.

Oystercatcher, *Haematopus* sp. Two bones.

Shag, *Phalacrocorax* sp. One individual identified from 5 bones. Probably either a Pied or Black Shag.

Grey Duck, *Anas superciliosa superciliosa* Gmelin. One bone.

Duck, *Anas* sp. One bone.

Charadriiformes. Not Black-backed Gull, Skua, Caspian Tern, Godwit or Oystercatcher. No comparable skeletal material available for positive identification. Three bones representing one individual.

Kiwi, almost certainly Little Spotted (or Grey), *Apteryx oweni* Gould. One bone.

Large Rail? Possibly *Gallirallus*. Four bones.

REPTILES

Tuatara, *Sphenodon punctatus* (Gray). Three individuals identified from 6 bones.

MAMMALS

Fur Seal, *Arctocephalus forsteri* (Lesson). Several individuals, adult and immature, were identified from approximately 40 bones, many of which were very fragmentary.

Polynesian Dog, *Canis familiaris* Linne, Polynesian subsp. A minimum of four individuals were identified from 20 bones.

FISH

Snapper, *Chrysophrys auratus* Forster.

Clay Layer Beneath Ash

BIRDS

North Island Kaka, *Nestor meridionalis septentrionalis* Lorenz. Two individuals identified from 10 bones.

Spotted Shag, *Phalacrocorax* (*Stictocarbo*) *punctatus punctatus* (Sparrman). Two bones.

Northern Blue Penguin, *Eudyptula minor novaehollandiae* (Stephens). Three bones.

Extinct Crow, *Palaeocorax moriorum* Forbes. One bone.

Gannet, *Sula bassana serrator* Gray. One bone.

FISH

Snapper, *Chrysophrys auratus* Forster.

TABLE 2

FAUNAL REMAINS, N38/24

Above Ash

LEVEL 1

Polynesian Dog, *Canis familiaris* Linne, Polynesian subsp. One bone.
Snapper, *Chrysophrys auratus* Forster. Many bones.

LEVEL 2

Polynesian Dog, *Canis familiaris* Linne, Polynesian subsp. Six bones.
Snapper, *Chrysophrys auratus* Forster. Many bones.

LEVEL 3

Polynesian Dog, *Canis familiaris* Linne, Polynesian subsp. A minimum of four individuals identified from 17 bones.
Northern Blue Penguin, *Eudyptula minor novaehollandiae* (Stephens). Four bones.
Fluttering Shearwater, *Puffinus gavia* (Forster). Again, clearly not *P. gavia huttoni.* Two, possibly three bones.
Snapper, *Chrysophrys auratus* Forster. Many bones.

LEVEL 4

Polynesian Dog, *Canis familiaris* Linne, Polynesian subsp. A minimum of 6 individuals identified from 49 bones.
Northern Blue Penguin, *Eudyptula minor novaehollandiae* (Stephens). A minimum of 3 individuals identified from 4 bones.
Tui, *Prosthemadera novaeseelandiae novaeseelandiae* (Gmelin). Three bones.
Spotted Shag, *Phalacrocorax* (*Stictocarbo*) *punctatus punctatus* (Sparrman). One bone.
North Island Kaka, *Nestor meridionalis septentrionalis* Lorenz. Eight bones.
New Zealand Quail, *Coturnix novaezealandiae novaezealandiae* Quoy and Gaimard. Three bones.
Whale, ? Two possible fragments.
Snapper, *Chrysophrys auratus* Forster. Many bones.

TABLE 3

DISTRIBUTION OF SHELL BY LEVEL, N38/24

SHELL	LEVEL 1	2	3	4	Below ash
Amphidesma australe, pipi.	x	x	x		
Amphidesma subtriangulatum		x	x	x	
Cellana radians		x	x		
Chione stutchburyi, cockle.	x	x	x	x	x
Cominella adspersa	x		x		
Cominella glandiformis	x				
Cominella maculosa				x	
Cookia sulcata, Cook's Turban.	x	x	x	x	
Crassostrea glomerata, Rock Oyster.	x	x	x	x	x
Evechinus sp., Sea Urchin.		x	x	x	
Glycymeris laticostata, Dog Mussel.		x	x		
Haliotis iris, paua.	x	x	x		
Haustrum haustorium	x	x	x		
Lunella smaragda, Cat's Eye.	x	x	x		
Maoricolpus roseus	x		x	x	
Maoricrypta costata				x	
Melagraphia aethiops	x		x	x	
Neothais scalaris	x	x	x	x	
Nerita melanotragus			x	x	
Pecten novaezelandiae, Scallop.	x				
Penion adustus			x	x	
Perna canaliculus, Common Mussel.		x	x	x	x
Scutus breviculus			x		
Struthiolaria papulosa			x		
Xymene plebejus			x		

TABLE 4

COMPOSITION OF STRATA ABOVE ASH, N38/24

LEVEL	COMPOSITION lb./%		
	Soil	Shell	Stone
1	29.035	4.100	0.200 lb.
	87%	12%	1%
2	24.005	0.380	2.080 lb.
	93%	0.5%	6.5%
3	20.015	7.050	3.025 lb.
	66%	25%	8.3%
4	51.460	1.300	3.465 lb.
	95%	2%	4%

The greatest number of shell species occurred in level 3, which also had the greatest concentration of shell in relation to other constituents (Table 4). Both rocky shore and soft shore species were well represented at all levels, with rocky shore species generally better represented in this site than in N38/30 and N38/37.

Composition of Layers

An analysis by weight of the principal constituents of the layers above the ash was made. Table 4 gives the weight of each constituent and its percentage of the total weight of each layer of the column sample.

From this it can be seen that level 3 contained the most concentrated cultural remains, with the highest percentages of shell and stone. Level 1 had the next highest concentration of shell, but the smallest stone constituent of all layers, reflecting its lack of stone working and purely kitchen midden nature; levels 2 and 4 had relatively little shell, and a higher stone constituent, indicating stone working on the site.

The total area sampled was small. Although, on the basis of the column sample supported by observation of the excavated area, level 3 contained the most concentrated deposits of both artifactual and midden remains, it is not impossible that this situation varies and other levels contain more concentrated remains in other parts of the site.

Artifacts

Analysis of artifactual material from this site was not completed before the author departed from New Zealand. A brief description of the artifacts is presented in Appendix 2.

CONCLUSIONS

The cultural evidence from this site indicates that it was occupied on three successive occasions by people with an Archaic material culture, evidenced by adzes mostly in the process of manufacture, and some items of fishing gear. The first of

these occupations was before the eruption of the Rangitoto ash and two (represented by levels 3 and 4) were after it. Some evidence indicates that the same tradition of adze manufacture was continued in a fourth occupation (level 2), although only a small amount of artifactual material was recovered from this level. The final occupation (level 1) indicates use of the site for cooking only. This may reflect a temporary occupation of a specialised kind, but may also mean that the use of the greywacke for adze manufacture had ceased. No dates are available for the site apart from the independent dating of the Rangitoto ash shower.

A major contribution of the excavation was the recovery of a considerable amount of bone, particularly from earlier levels. The bone from deposits beneath the ash is important as it is the only extensive faunal collection of this age from the Auckland area, and indicates the range of fauna available to early Polynesian settlers. Also significant is the marked decrease in faunal remains in post-ash-shower deposits, to the reliance in levels 1 and 2 on fish and Polynesian dog.

The excavation verified the occupation of Motutapu before the ash shower from Rangitoto. The results of the excavation of four squares, through four post-eruption occupation levels, supplement the results of Golson's earlier excavations at Pig Bay (N38/21), in indicating occupation characterised by Archaic artifacts; levels 1 and 2, however, suggest that Archaic material culture did not persist throughout the prehistoric sequence on Motutapu. The major significant advance of this excavation beyond the earlier Pig Bay excavation lies in the recovery of the artifactual and faunal material from beneath the ash, showing conclusively that the island was occupied before the ash shower by people who were able to exploit a wide range of birds and other fauna then available in the vicinity. This wide range of fauna, contrasting with the more restricted range from later levels, suggests that the initial occupation of the site belongs to the Settlement phase.

APPENDIX 1 — NOTES ON LEAVES FROM SITE N38/24

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The leaves found immediately beneath the Rangitoto ash have been identified as follows:

(1) Pohutukawa, *Metrosideros excelsa* Gaertn., Myrtaceae. A canopy tree, common in northern coastal forest.

(2) Karaka, *Corynocarpus laevigatus* J. R. & G. Forst., Corynocarpaceae. A canopy tree, found in northern coastal and lowland forest.

(3) Kawakawa, *Macropiper excelsum* Miq., Piperaceae. An aromatic shrub or small tree, common in coastal and lowland forest.

(4) I am unable to decide whether this specimen (Fig. 3) is rewarewa, *Knightia excelsa* R.Br., Proteaceae; titoki, *Alectryon excelsus* Gaertn., Sapindaceae; or an "unknown". The matrix of Rangitoto ash is coated with fish scales. Specimens of the matrix were submitted to Dr. N. T. Moar, Botany Division, D.S.I.R., Christchurch, for pollen analysis, but pollen could not be obtained from them.

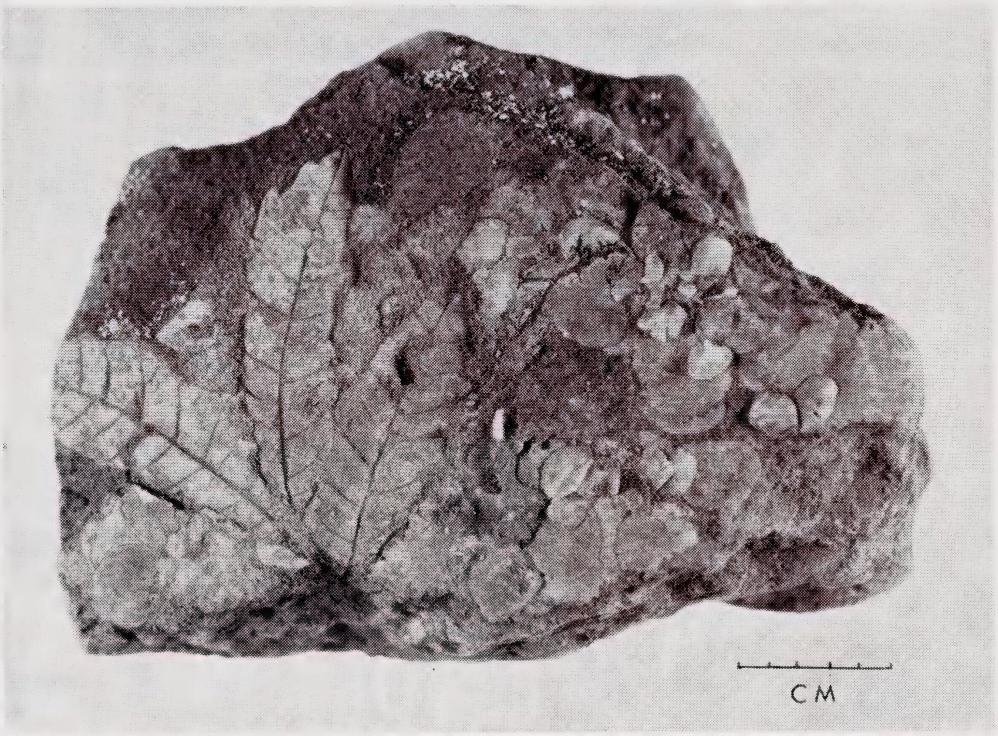

FIG. 3. A leaf and fish scales on the undersurface of ash from site N38/24, Sandy Cove, Motutapu Island.

APPENDIX 2 — NOTES ON ARTIFACTS FROM SITE N38/24

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The artifactual material recovered from the site was relatively sparse in comparison with the rich faunal remains. The excavated artifacts have been supplemented by limited surface collections from the vicinity of the site both before and after the excavation in 1963.

FISHING GEAR

A lure shank and portions of two one-piece bone hooks were found, as well as a small range of material indicating fishhook manufacture.

The point leg, bend, and part of the shank leg of a one-piece bone hook (AU 1561/298, Fig. 4c) was found beneath the Rangitoto ash. A portion of a similar hook was found *in situ* in the eroding section, beneath the ash, prior to the excavation. A partly worked bone tab (AU 1576/5, Fig. 4b), indicating fishhook manufacture, was found in level 4, square B-1. A small drilled-out central core (AU 1565/37) from fishhook manufacture was found in level 3, and a larger core (Fig. 4d) was collected from the eroding section and probably from beneath the ash.

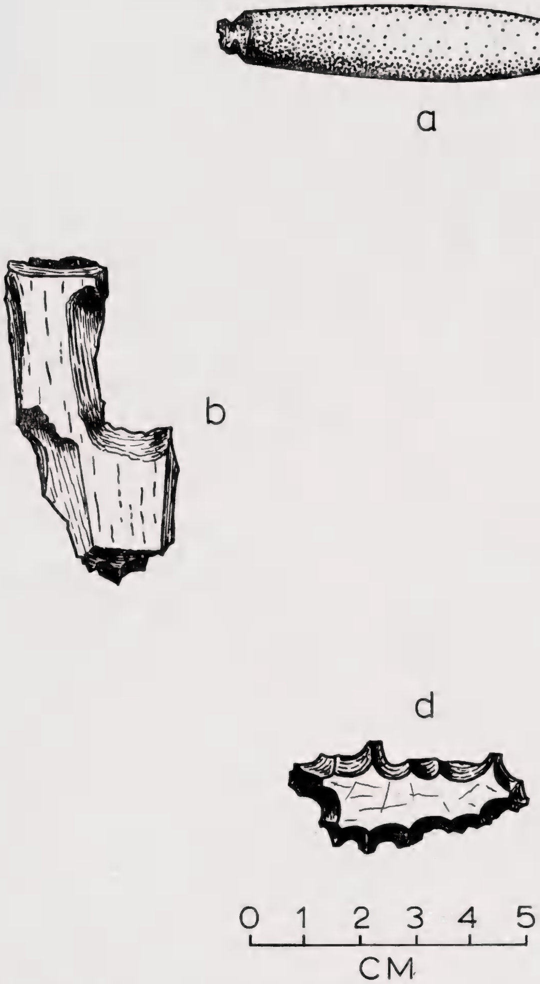

FIG. 4. Bone artifacts from site N38/24, Motutapu Island: a. lure shank, AU 1565/35. b. partly worked tab, AU 1576/5. c. one-piece hook, AU 1561/298. d. core.

A bone lure shank (AU 1565/35, Fig. 4a) and a small portion of a second lure shank were recovered from level 3, square A-1. As can be seen from the illustration, the complete lure is flat-oval in section, and grooved rather than perforated for line attachment. In size and shape it resembles a surface find from N38/21; the latter has a dorso-ventral perforation however. No lure points were found.

OTHER BONE ARTIFACTS

Two other pieces of worked bone were found. A dog canine, with an uncompleted drilled hole at the proximal tip, was found in level 1, square B-2. A piece of worked bone of doubtful purpose was recovered from level 3 in square A-1.

ADZES

The most frequent artifacts from the site were roughout adzes, which occurred in all levels except level 1. All appear to have been worked by flaking; a few show

signs of hammer dressing and one is partly ground. All appear to have been rejects, and the quality of flaking exhibited is not good. All appear to be made in local greywacke. Roughouts recovered from beneath the Rangitoto ash layer included both quadrangular and triangular sectioned specimens. The two largest examples both conformed to Duff's type 4 (1959, p. 137), and were remarkable in being noticeably thicker than they were wide. Two roughouts, one of which was in two pieces (Fig. 5a), had a diamond-shaped cross-section. The single fragment with rectangular cross-section was the smallest recovered from beneath the ash, and was relatively wide and thin. It was probably a roughout for an adze of Duff's type 2A.

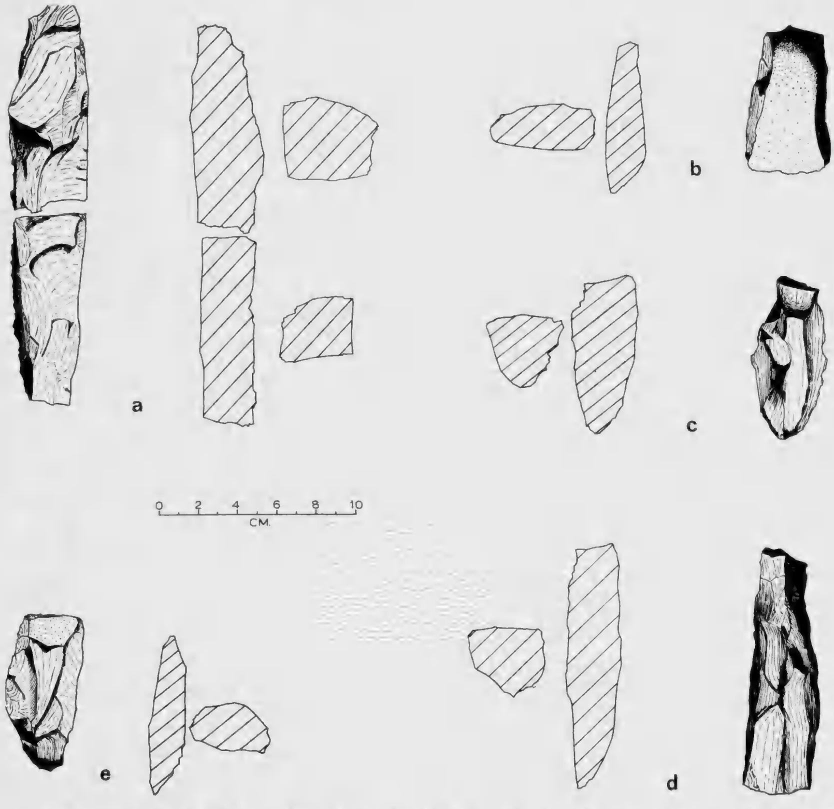

FIG. 5. Adze roughouts from site N38/24, Motutapu Island: a. broken roughout from beneath ash, AU 1561/388. b. roughout from level 4, AU 1568/1. c. fragment from level 4, AU 1576/1. d. roughout from level 3, AU 1565/8. e. roughout from site, AU 1604/3.

A single complete adze was recovered from level 4 (Fig. 5b). It is quadrangular in section, front narrower than back, and the front surface is formed by an unmodified pebble face. The sides, back, and bevel have been worked by flaking. Several fragments of roughouts were also recovered from level 4, including both rectangular and triangular sectioned specimens. AU 1576/1 (Fig. 5c) is a typical example, roughly flaked with some hammer dressing. Three specimens were catalogued as roughouts from this level, but several smaller fragments of roughouts, classified with the worked flakes, were also recovered.

The largest number of adzes came from level 3. There were 17 recognisable roughouts and several fragments which are probably parts of discarded roughouts. Both triangular and rectangular sectioned examples occur, and there are also several fragments with diamond-shaped cross-sections. AU 1565/8 (Fig. 5d) is one of the more complete examples from this level, and is hammer dressed as well as flaked. One small adze was partially ground, and is not unlike the smaller of the two adzes from N38/30 (Leahy, this volume).

Two butt ends of roughouts were recovered from level 2. Both are quadrangular in section.

In addition to the adzes from known context in the squares, several other specimens are known to be from above the Rangitoto ash, although their exact level is uncertain. These include roughouts of triangular and quadrangular section, similar to examples from levels 2, 3, and 4. In addition, there is a bevel section of a highly polished adze of Duff's type 4. A more unusual specimen is a small adze (Fig. 5e), made on a flake, which has a triangular section with apex down, and on which the bevel appears to be formed from a water-worn pebble surface.

Although the specimens from the site are mostly fragmentary, they indicate that adzes of Duff's types 1, 2, 3, and 4 were present. The extent to which butt modification was present is not clear from the examples recovered. At least one fragment appears to be the butt end of a type 1A, however. The range of types is present up to level 3. The two examples from level 2 are both quadrangular, so it is not known whether the type 4 adze was still present at this stage.

In contrast to site N38/30 (Leahy, this volume), where abundant evidence of stone working was found, the roughouts from this site were not accompanied by convincing evidence of manufacture on the spot. No hammer stones were recovered from context except for a very small specimen which may be a hammer stone from level 1. No grindstones were found, and the numbers of stone flakes are very small. The explanation for the presence of so many roughouts is difficult. The roughouts themselves indicate that adzes were being made from local greywacke occurring in fairly handy-sized pieces. A number have traces of weathered cortex, or water-worn pebble surfaces.

FISHHOOK MANUFACTURE

More evidence for fishhook manufacture was present on the site. A number of drill points fashioned from greywacke were found, as well as one chert drill point. The latter was from level 4, while greywacke examples were found beneath the ash and in levels 2 to 4. Typical examples are illustrated in Fig. 6.

Two files suitable for working fishhooks were found in the site, both from above the ash, and one from a certain layer 3 context (Fig. 7a). A small number of chert flakes were found in level 2 and earlier contexts.

PEBBLE CHOPPER

A remarkable flake tool (Fig. 7b) was found on the surface of the site before excavation commenced. It is a large flake, struck from a pebble or water-worn boulder,

and has been further shaped by flaking to form a grip so that it closely resembles the Easter Island *mataa* (Heyerdahl and Ferdon 1961, pl. 75).

OBSIDIAN

A relatively small quantity of obsidian was found in the site. This was analysed for age and source by Green, and is included in a comparison of obsidian from a number of sites (Green 1964, pp. 135, 138 and 141). The single flake from beneath the ash gave a greater hydration rim measurement than any other obsidian from the Auckland province. The obsidian is no longer available for technological study.

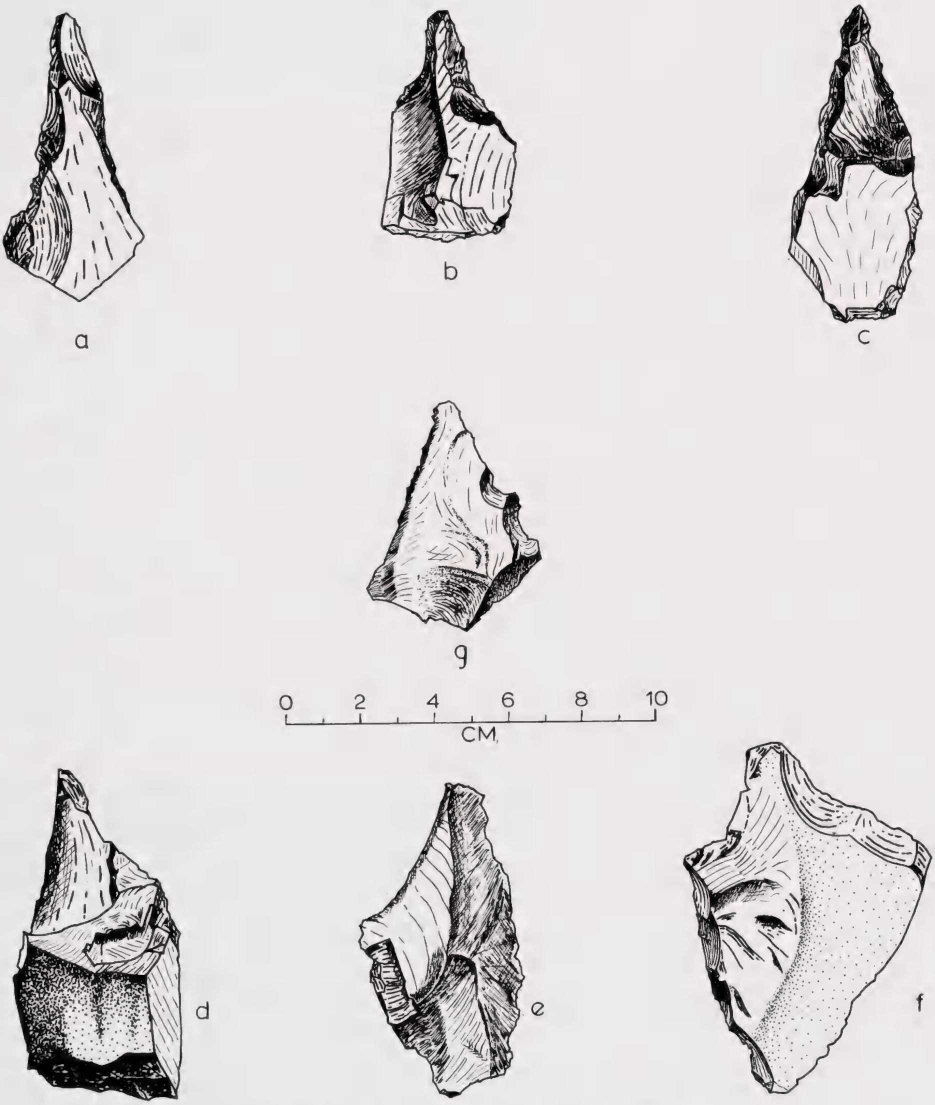

FIG. 6. Stone drill points from site N38/24.

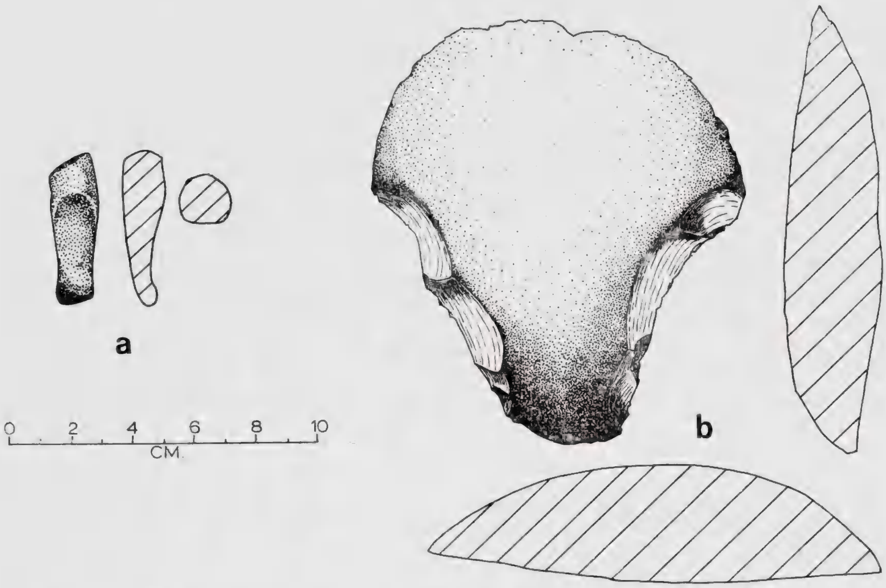

FIG. 7. Miscellaneous artifacts from site N38/24: a. file from layer 3, AU 1590/8. b. flake tool from surface, AU 1604/1.

SUMMARY

The artifactual evidence indicates the use of the site from before the eruption of the Rangitoto ash through levels 4 and 3 by people with an Archaic material culture similar to that reported by Golson (1959) for the Pig Bay site. The principal features are one-piece fishhooks of bone, bone lure shanks, items associated with the manufacture of fishhooks including drill points and files, and adzes of rectangular and triangular cross-section shaped predominantly by flaking. The more restricted range of items from level 2 is less diagnostic, but the presence of flaked adze roughouts, and drill points, suggests a probable continuity of culture between this and earlier levels. The latest occupation of the site, however, lacks these artifacts, and may belong to a different phase of occupation.

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EXCAVATION OF AN "UNDEFENDED" SITE, N38/37, ON MOTUTAPU ISLAND, NEW ZEALAND

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Abstract. N38/37, an undefended site on Motutapu Island, was excavated in the 1967-8 season. Structural and artifactual evidence indicated several occupations of an undefended village, probably belonging to a Motutapu Aspect of the Early Maori Phase.

The site survey in 1963 led to the recording on Motutapu of a large number of "undefended" sites indicated in the field only by slight depressions in the ground with a more luxuriant growth of grass at certain times of the year. These ranged in size from single pits, through groups of two, three or four, to extensive areas of terracing. While some sites could clearly be seen to be pits, others were so vague in their definition that it was sometimes difficult to be confident that they were sites at all. An initial aim of the excavation season in 1967-68, therefore, was to test one or more of these poorly defined sites to determine what subterranean features were causing the field evidence so widely recorded on the island.

It was hoped that the presence of pits and/or surface house structures might be revealed, and a contribution made towards the definition of domestic or communal units of settlement. The problem of interpreting pits as sunken houses or as food stores was still being hotly debated, as was the validity or usefulness of pits as artifacts which could be subjected to typological analysis. Groube's (1965) discussion of settlement patterns had demonstrated the need for excavation of hamlets or undefended settlements, particularly those of Classic Maori age, and a better definition of domestic units for both Archaic and Classic phases. The large number of undefended sites on Motutapu appeared to offer a suitable field of enquiry.

The other major reason for choosing a site on Motutapu related to theoretical considerations of a different kind. A major and continuing consideration of New Zealand archaeologists is the attempt to document the changes which must have taken place from Archaic to Classic Maori phases (Golson 1959, Green 1963a). Excavations previously conducted on Motutapu had apparently demonstrated a continuity in Archaic material culture until the 17th century — far later than was expected for the Auckland area.

How did the Archaic working floors relate to the numerous pit and terrace sites on the island? Both Golson and Green had tended to regard Motutapu and perhaps other gulf islands as a special case, in which an Archaic material culture and (implicitly) economy lingered on after a presumed change to full Classic Maori culture on the Auckland Isthmus. Neither writer, however, had attempted to speculate on the relationship of the excavated sites to the other forms of field evidence occurring

on the island. There appeared to be two main alternatives; either the pit and terrace sites were later, and reflected a late intrusion of Classic Maori on to the island, replacing the Archaic phase, or the pit and terrace sites were contemporary at least with the upper layers of the beach middens and represented different components of the same phase and aspect.

The aims of the excavations accordingly were two-fold; to identify the structures underlying the visible field evidence and uncover the lay-out and if possible the function of one or more undefended sites; and to establish the cultural and temporal relationships between these sites and the beach middens previously excavated. These enquiries were seen as part of a continuing programme of investigation of Auckland prehistory.

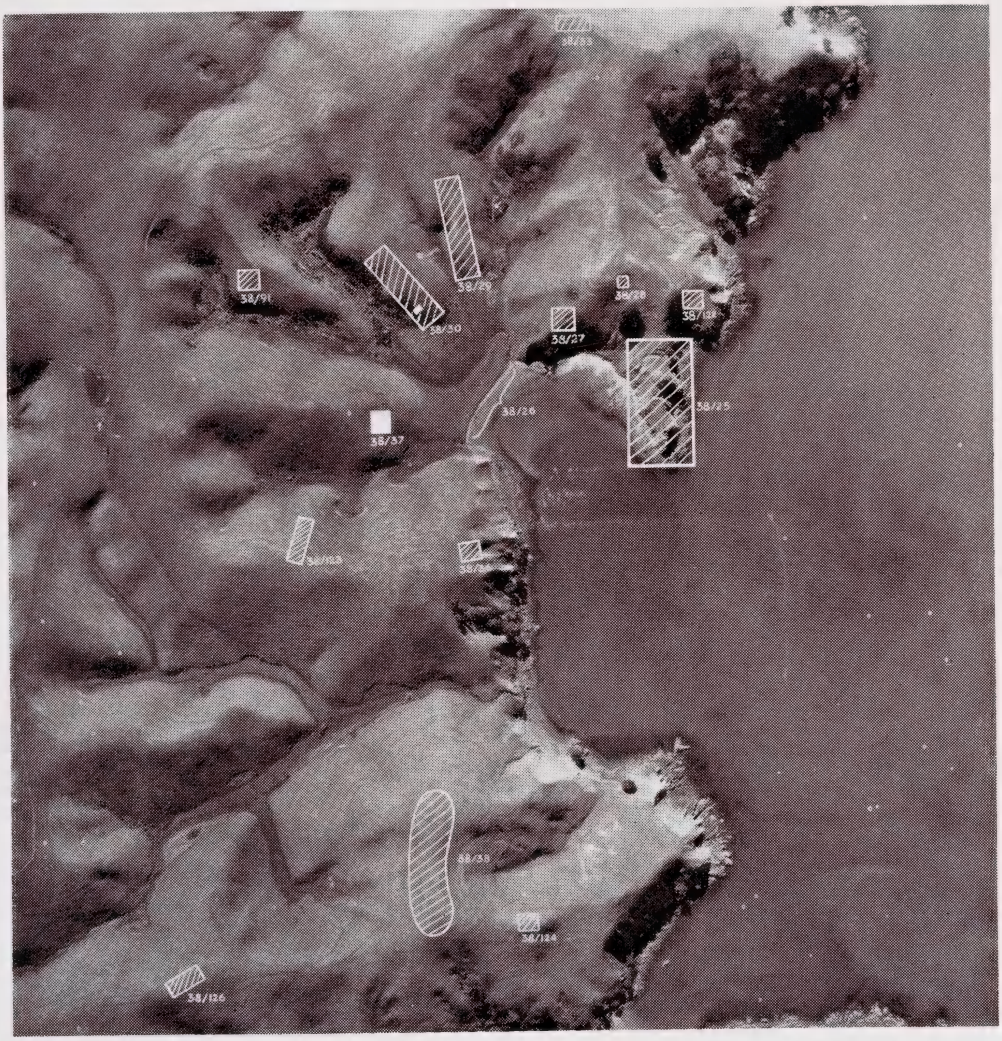

FIG. 1. Aerial photograph of Station Bay, Motutapu Island, showing the position of recorded archaeological sites. Approximate scale: 1 inch = 14 chains (1 cm = 111 m). Reproduced by courtesy of the Lands and Survey Department.

THE SETTING

Choice of site, once the initial decision to excavate an undefended site or sites on Motutapu had been made, was dictated by practical rather than purely archaeological considerations. Station Bay, on the north-east side of the island was selected as a research area. The bay is dominated by a headland pa (N38/25) while most of the ridges fingering down towards the bay have field evidence of the sort to be investigated (Fig. 1). The bay itself provides a sheltered anchorage and easy canoe landing in most weather, while the streams running into it provide a permanent water supply, albeit a minimal one, today, and are presumed to have been at least as adequate in the past.

There are some nine undefended sites in the vicinity of Station Bay. Excavations were carried out on two of them, N38/37 and N38/30. The rest of this report describes the results of investigations at N38/37, while N38/30 is described in the following paper.

N38/37 is located on the broad ridge which separates the two main stream systems now draining into the bay (Fig. 2). It was chosen largely because a four-wheel-drive vehicle could easily be taken right to the spot, and because the site itself is one of the faintest and most poorly defined by surface features. It is located on a naturally flat area of ridge between the 50 and 100 feet (15-30 m) contours. Below the site, the ridge slopes steeply to the beach and to the stream gullies on either side. On the inland side, the ridge rises gradually to a spot height 202 feet (62 m) on the island's central ridge.

At the seaward edge of the flat area two patches of long green grass indicated some disturbance of the subsoil, while there appeared to be at least two broad shallow terraces to the east, and at least one to the north. Differential growth of grass on the terraces was further possible indication of pits.

THE INVESTIGATIONS

Excavation began on December 17th, 1967, and continued until January 13th, 1968. At the conclusion of the excavation, the site was refilled by mechanical means.

A grid of three-metre squares with one-metre baulks was set out on the site along a north-south axis. Some baulks were subsequently excavated and a few extensions made to uncover corners of pits, or to check important stratigraphic connections. The total excavated area is shown in Fig. 3. The form lines indicate the general conformation of the surface before excavation. The datum was fixed at a point on the slope to the west of the site, but for practical purposes a point at the south-west corner of square L-9 was used.

Initially, excavation commenced in squares L-9, L-10 and M-9, located on the flat area in the presumed centre of the site, where faint surface indications of sub-surface disturbance were apparent. The 8 row of squares was intended to provide a section down the northern slope through a terrace and/or pit feature, while the

FIG. 2. General view of N38/37 during excavation, with N38/25 in the background.

K row of squares was similarly intended to test a terrace on the eastern slope. These and remaining areas were opened as work progressed, depending on the fluctuations of the labour force.

Excavation on this site was largely done by hand trowel. Owing to the fact that a large number of those taking part were inexperienced, work progressed very slowly at times. As we were working initially in unfamiliar soil conditions, with little idea of what to expect, the necessarily slow progress meant that mistakes were largely avoided.

STRATIGRAPHY

Considerable confusion in interpreting the stratigraphy was experienced during the early stages of the excavation. This confusion arose because we had not expected

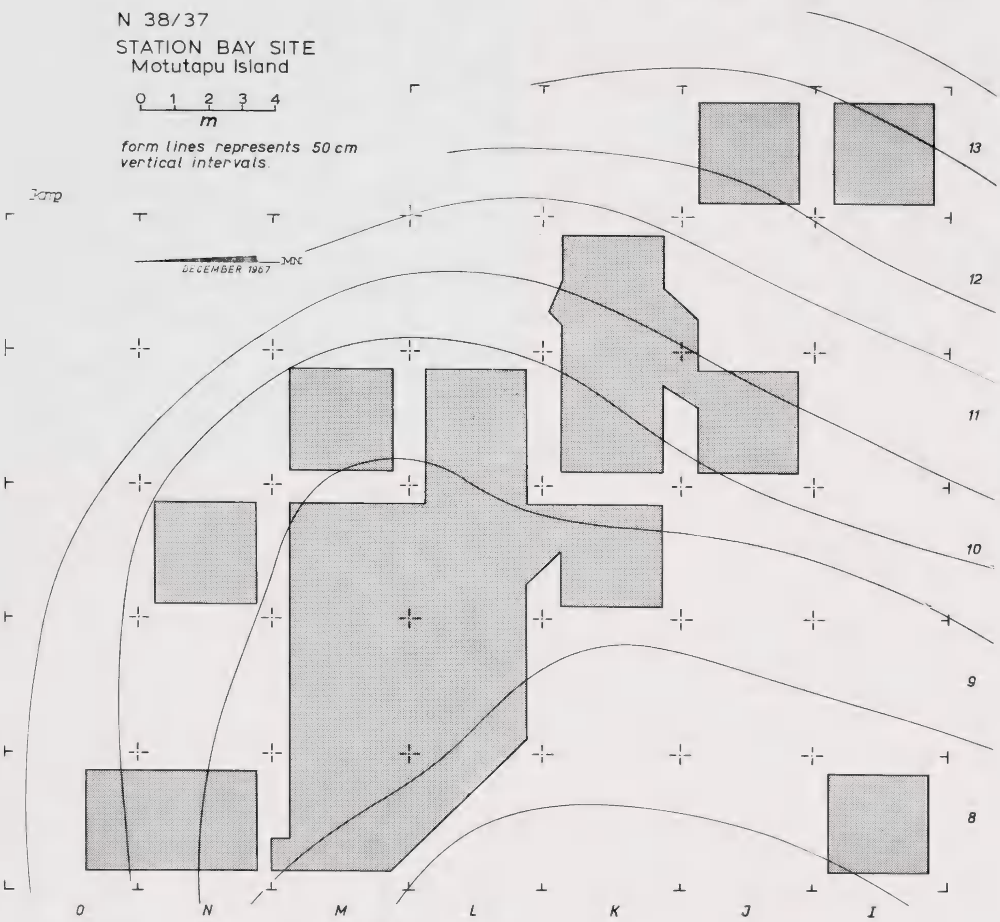

FIG. 3. Ground plan of N38/37 showing excavated area.

to find Rangitoto ash in quantity in this part of the island, and because the weathered clay subsoil was not accepted by many of the excavators as natural, and was indeed often very difficult to distinguish from the clay-derived layers which partially filled some man-made features.

The unmodified natural profile was well represented in square I-8, which was opened to test the flat, apparently undisturbed area to the south-west of the site. The stratigraphy, which was uniform throughout the square, consisted of:

(1) Fine humic topsoil, with occasional fractured stone and considerable charcoal near the surface, varying from 14-18 cm deep in the area tested.

(2) Windblown basaltic ash varying in depth from 16-35 cm.

(3) Weathered clay subsoil.

(4) Harder unweathered clay, natural.

No buried topsoil was evident between 2 and 3 but, in various places in this and other squares, charred twigs and other indications of burning were encountered at

the interface between 2 and 3 (cf. Brothers and Golson 1959, pp. 573-4). A similar profile was observed at N38/30 (Leahy, this volume), and is probably typical of this part of the island, the most variable layer being the windblown ash. Its variability and occasional total absence were noted in exposed sections in the side of sheep tracks or slips elsewhere in the vicinity.

The natural profile had been affected by human activity in a number of ways. In some areas the volcanic ash had apparently been cleared away during levelling activities, which had at times also penetrated the weathered clay. Pits of various kinds had been dug through both these layers into the underlying clay (Figs. 4 and 5). Midden material had accumulated in various parts of the site, and in some areas seemed to have been mixed with redeposited volcanic ash.

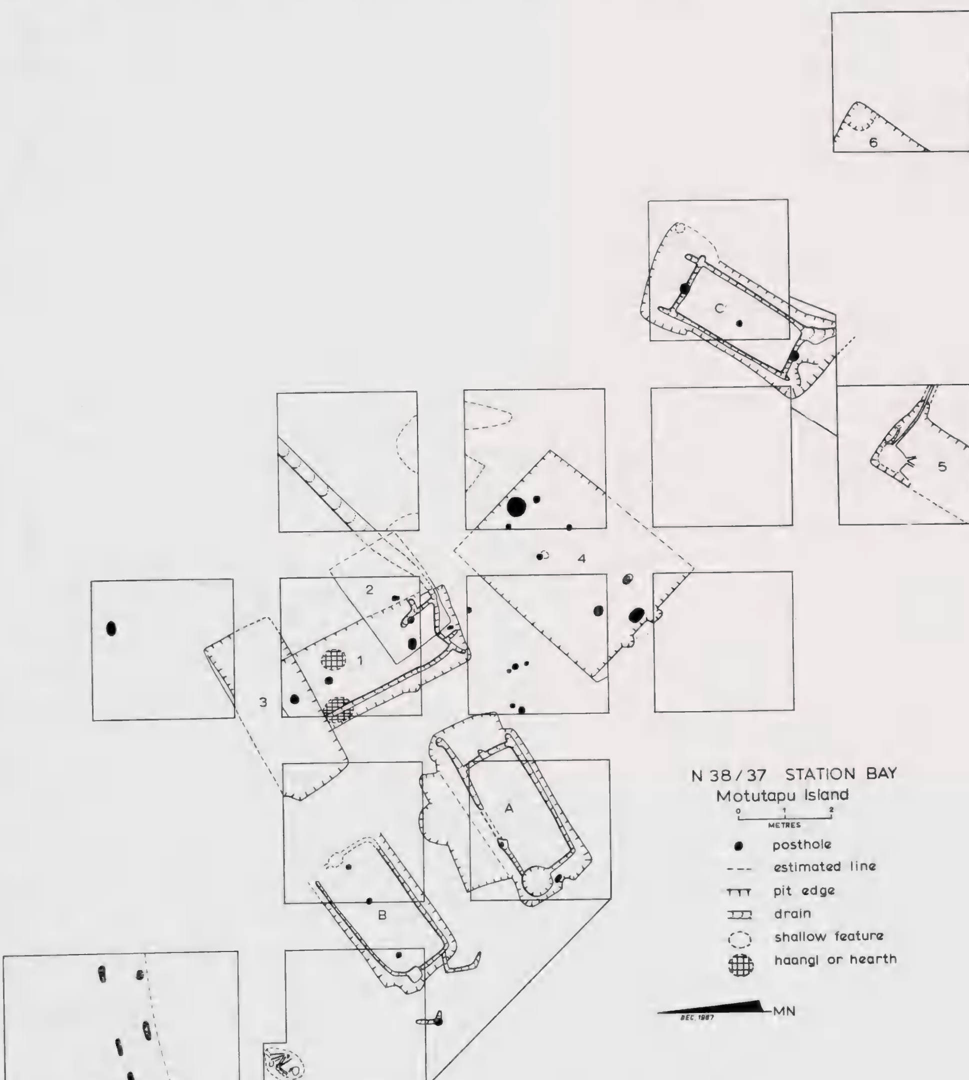

FIG. 4. Plan of features revealed by excavation, N38/37.

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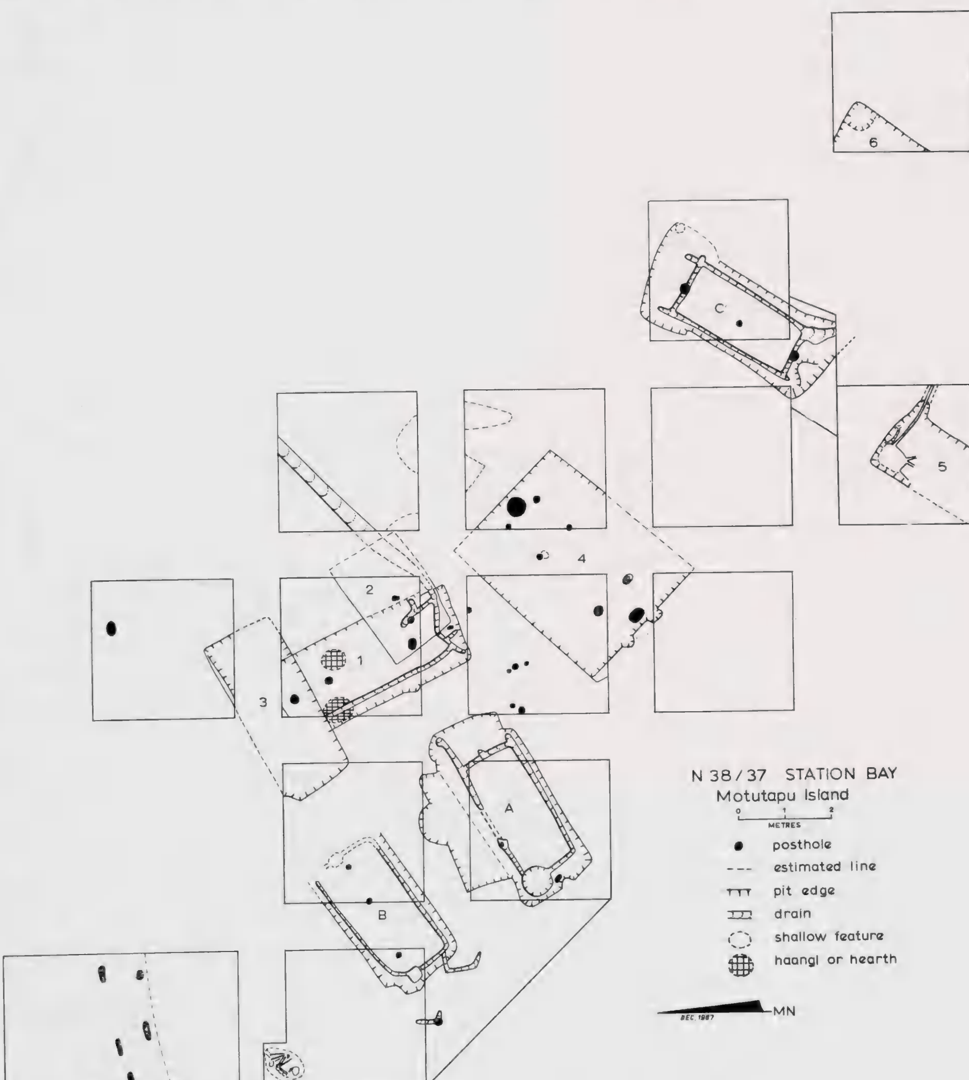


FIG. 4. Plan of features revealed by excavation, N38/37.

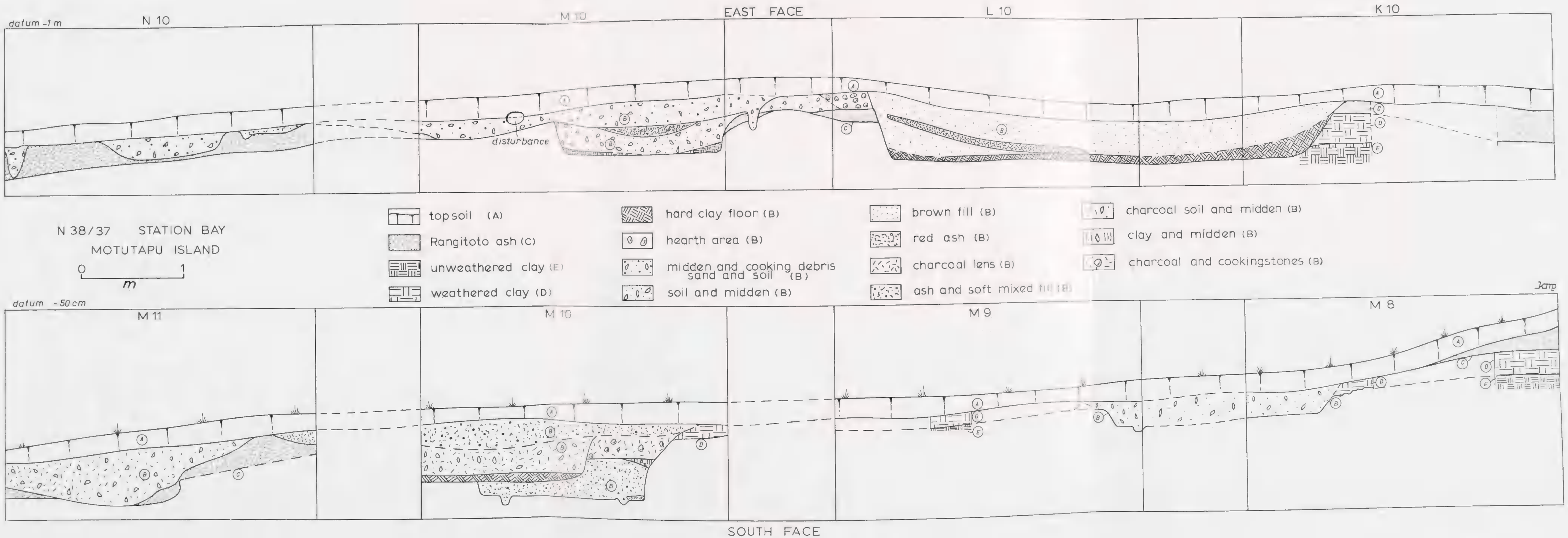
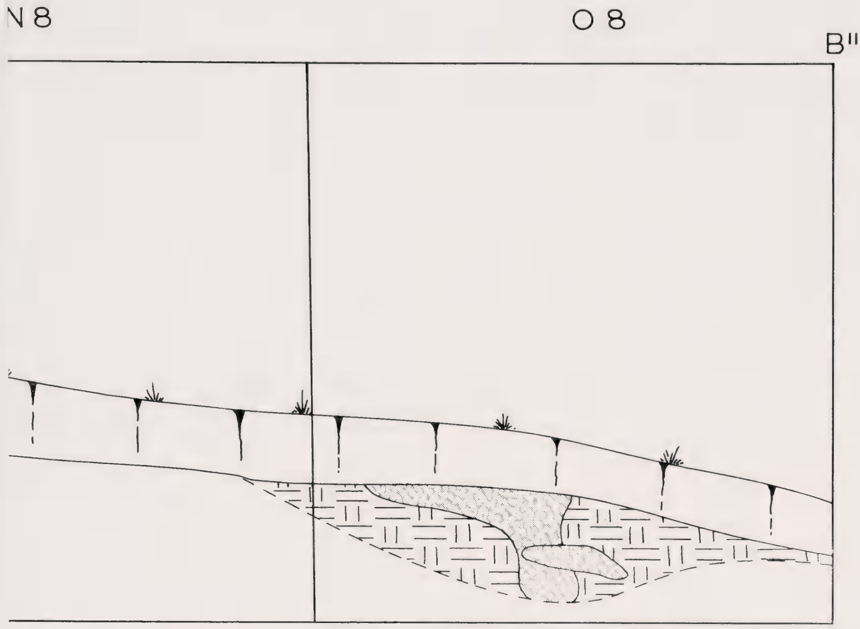


FIG. 5a. Principal cross-sections, N38/37.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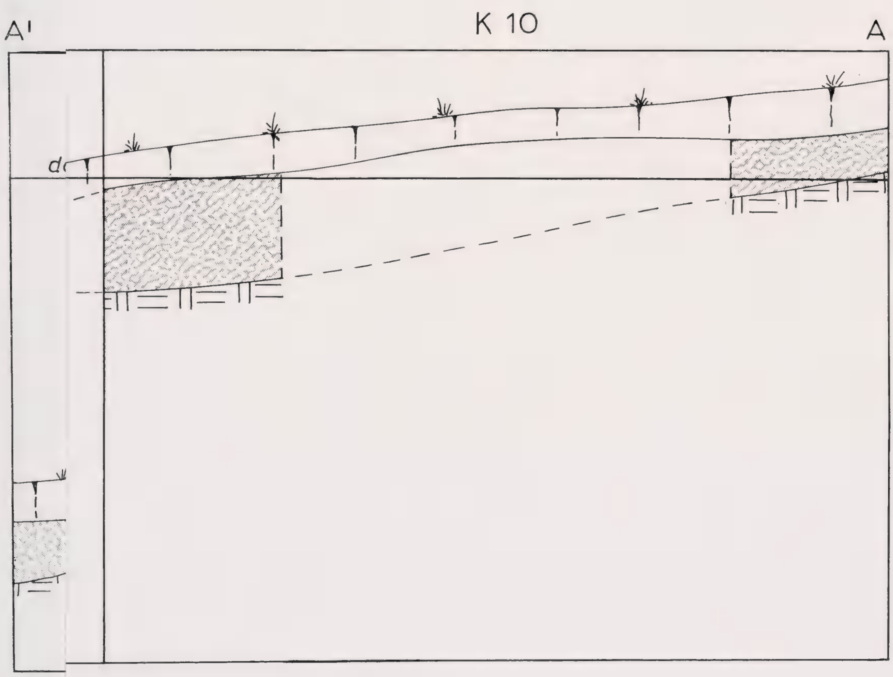
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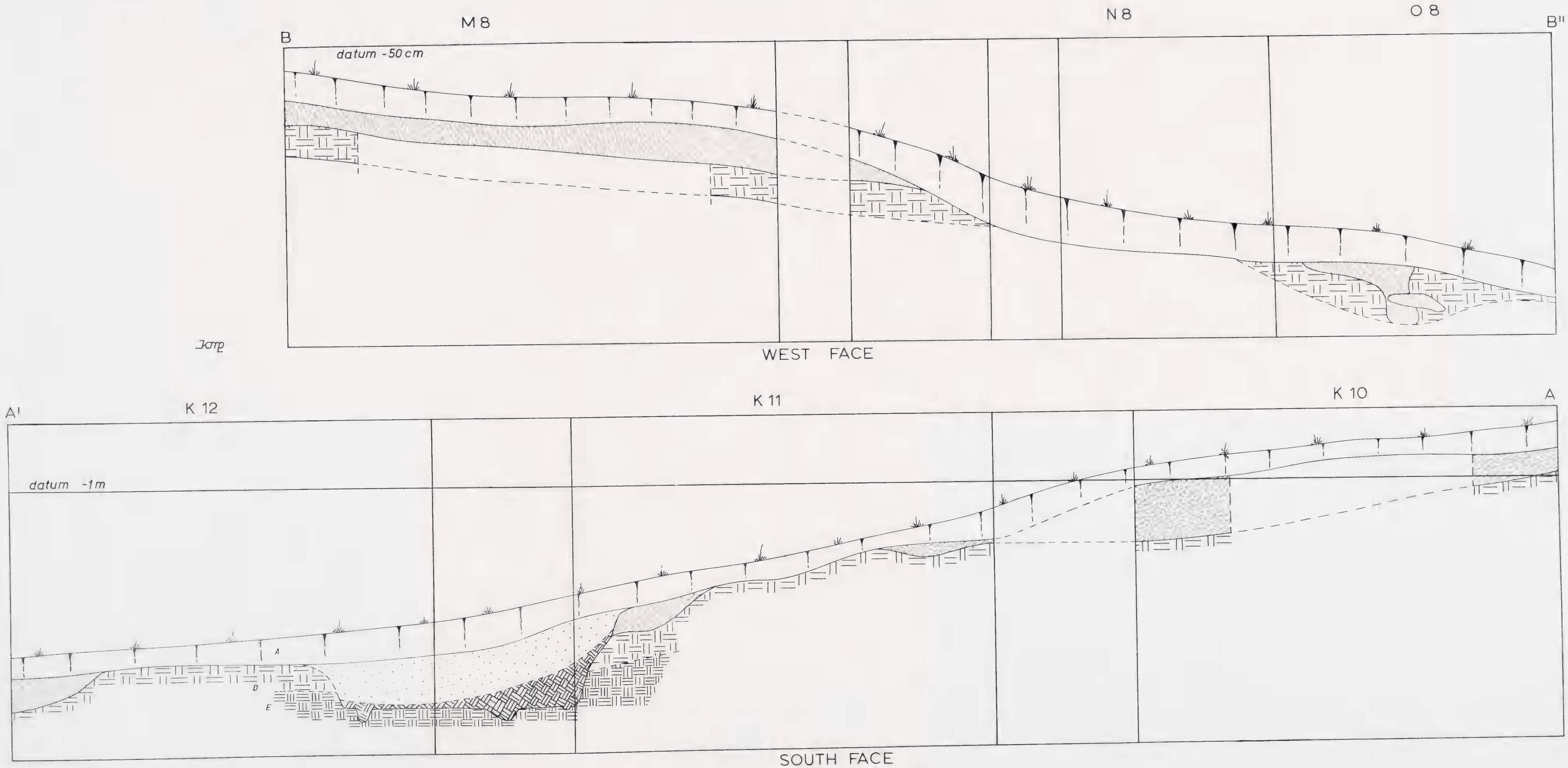

Fig. 5b. Principal cross-sections, N38/37 (continued).

With the possible exception of one posthole, no evidence of human activity on the site before the deposition of the volcanic ash was found. Thus, human activity may be regarded as postdating the deposition of layer 2. On the other hand, no instance of human activity on the site postdating layer 1 was found. This does not necessarily mean that occupation of the site began so soon after the eruption that no soil had developed on the ash; in those parts of the site where ash remained, however, midden layers were deposited directly on top of it. Over much of the site, thick layer 1 deposits were developed on top of layers resulting from human occupation.

Within the area of the site, the stratigraphy may be written as follows:

(A) Topsoil similar to (1) of the natural profile but containing scattered cultural remains.

(B) Those layers in the site resulting directly from human activity.

(C) Windblown ash.

(D) Weathered clay subsoil.

(E) Clay bedrock.

These layer enumerations are used in the cross-sections (Fig. 5). The major human activity on the site throughout its occupation was the construction of pits and terraces. At the same time, use of the site for cooking and eating led to the deposition of some cultural layers. Both kinds of activity, however, were on a sufficiently small scale that no layers resulting from human activity on the site were widespread, all being small, localised and discontinuous. Although all human deposits are grouped together as B layers, they show considerable variation, and must be described individually from area to area.

Culturally deposited layers occurred in squares L-9 and L-10 on the south side of structure A, and between structure A and pit 4. Here, a thin layer of dispersed midden, mainly fragmentary shell and fish bone, was mixed with disturbed volcanic ash. Two hearth-like areas were found in position, one on the southern edge of structure A, the other between pits 1 and 3, and pit 4, cut through by the latter. The greatest concentration of midden material, however, was in squares M-10, N-10, and M-11, which was apparently the principal cooking area of the site. Several *haangi* were found in N-10, while the pits in M-10, particularly pit 1, seem actually to have been used for cooking, as several *haangi* were discovered at various levels in the fill of the pit. The focusing of cooking activities in this area is reflected by the large quantity of *haangi* stones recovered in these squares, compared with the rest of the site. (Allo, this volume). M-11, on the other hand, seems to reflect the dumping of midden waste on the edge of the slope, and although no excavation was conducted on the steep slope below this square, surface inspection revealed quantities of midden scattered down the slope for some distance. The midden layer in M-11 extended into the full northern portion of L-11.

The principal activity on the site was digging of various pit structures, which subsequently filled either naturally or deliberately. In several instances, intercutting pits were found, showing that not all features on the site were occupied contemporaneously. It is not possible, however, on stratigraphic grounds, to relate all pits to a single chronological sequence. As is so often the case, correlation of features in

different parts of the site must be based on such unsatisfactory evidence as similarity or difference in fill, or alignment (cf. Shawcross 1964a, p. 85). The nature of the infilling of the pits, and their probable temporal relationships are discussed in the following sections.

Structural Evidence

Evidence of ten subsurface structures was encountered in the site. These were not all contemporary, nor all of similar form. They have been divided into two separate categories for descriptive purposes: "structures" and "pits". These terms were assigned during the excavation and it has seemed convenient to retain them. They need not, however, reflect a difference in function.

The ground plan of all features in the excavated area is shown in Fig. 4, while cross-sections of structures B and C, and pits 1, 2 and 4 appear in Fig. 5.

Structures A, B, and C showed certain resemblances to each other, and differed from other excavated features on the site. The walls of structure A varied between 20 and 40 cm. The floor sloped far more markedly than is normal in pits, with a difference of more than 30 cm between the highest point (the south-west corner) and the lowest point (the north-east corner). The floor plan was characterised by a drain-like feature with a large circular hole 35 cm deep filled with compacted, ash-like material, at the higher end. There is a vestigial buttress at this end with a 15 cm deep posthole in front of it.

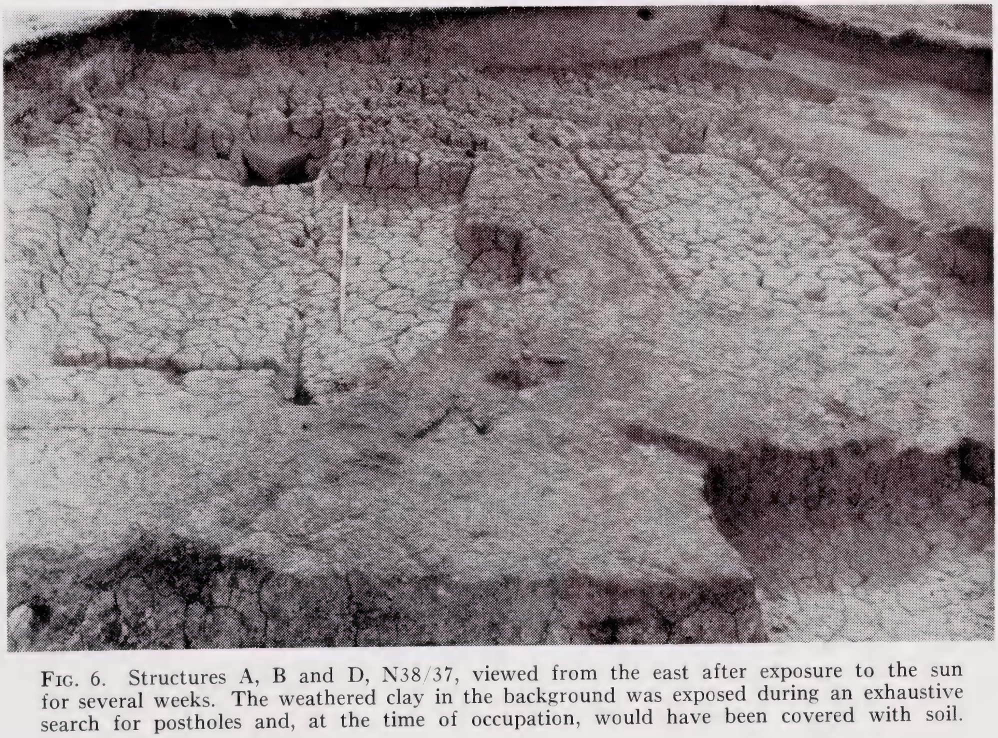

Fig. 6. Structures A, B and D, N38/37, viewed from the east after exposure to the sun for several weeks. The weathered clay in the background was exposed during an exhaustive search for postholes and, at the time of occupation, would have been covered with soil.

Structure A was cut into and had largely destroyed structure D, a rectangular structure of similar size and slightly different alignment, which was filled with a hard compact clay containing no cultural material. Structure D lacked drains or postholes in the surviving portion of its floor, but was marked by a circular extension in the centre of its long side (Fig. 6).

Structure B (Fig. 6) was shallower (maximum depth 30 cm), and slightly smaller than structure A, but was aligned parallel to it, and very similar in style. Unlike A, its floor was almost level, and it was covered with a mixture of ash and soil flecked with bone fragments and charcoal, whereas A had apparently been left open when the site was finally abandoned, and had gradually filled by natural processes. The sump in structure B was 40 cm deep. A line of stake holes slightly off centre averaged 13 cm deep. They may belong either to structure B or to a separate feature.

Structure C (Fig. 7) resembled the others in its sled-like drain arrangement and general shallowness. It had a buttress at one end, and its drain ran out in a channel. Like A, structure C appears to have filled naturally. The central postholes at either end were slightly more than 20 cm deep.

Pit 1 (Fig. 8) was probably the earliest feature on the site, and also the best constructed. It was a long rectangular pit with two central postholes (24 and 27 cm deep) large enough to support substantial posts, and two shallow postholes in the

Fig. 7. Structure C, N38/37, from the north-east.

FIG. 8. Pit 1, N38/37, from the north.

same line where bracing posts probably rested. The curious floor drain ran out through a narrow slit in the wall, and became a deep V-shaped channel in square M-11. A remarkable feature of this pit is its use as a cooking area. The fill consisted of layers of cooking debris, charcoal, stones and scattered midden. Actual *haangi* pits were found at various levels in the fill, indicating that cooking took place in the depression formed by the pit.

Two shallower rectangular pits, 2 and 3, were cut across pit 1 after it had been entirely filled with cooking debris. Both had a thin layer of clay trampled on to the floor where they were cut into the soft material filling pit 1. Pit 2 had two central postholes (12 and 17 cm deep) and no drain, while no floor features were encountered in the excavated portion of pit 3. Both of these pits were also filled with midden debris, but it was more dispersed, and evidence that cooking actually took place in the pits was lacking.

Pit 4 was a broad shallow rectangular pit which lacked drains. The posthole pattern is evident in Figs. 4 and 9, and suggests a possible internal rack structure. The postholes ranged from 11 to 16 cm in depth. The north-south cross-section (Fig. 5) shows that this pit was cut through a hearth area which is clearly later than pit 1. Unfortunately, its relationship to pit 2 is not clear, although it is probable that pit 4 also postdates pit 2. Pit 4 appeared to have filled largely by natural processes.

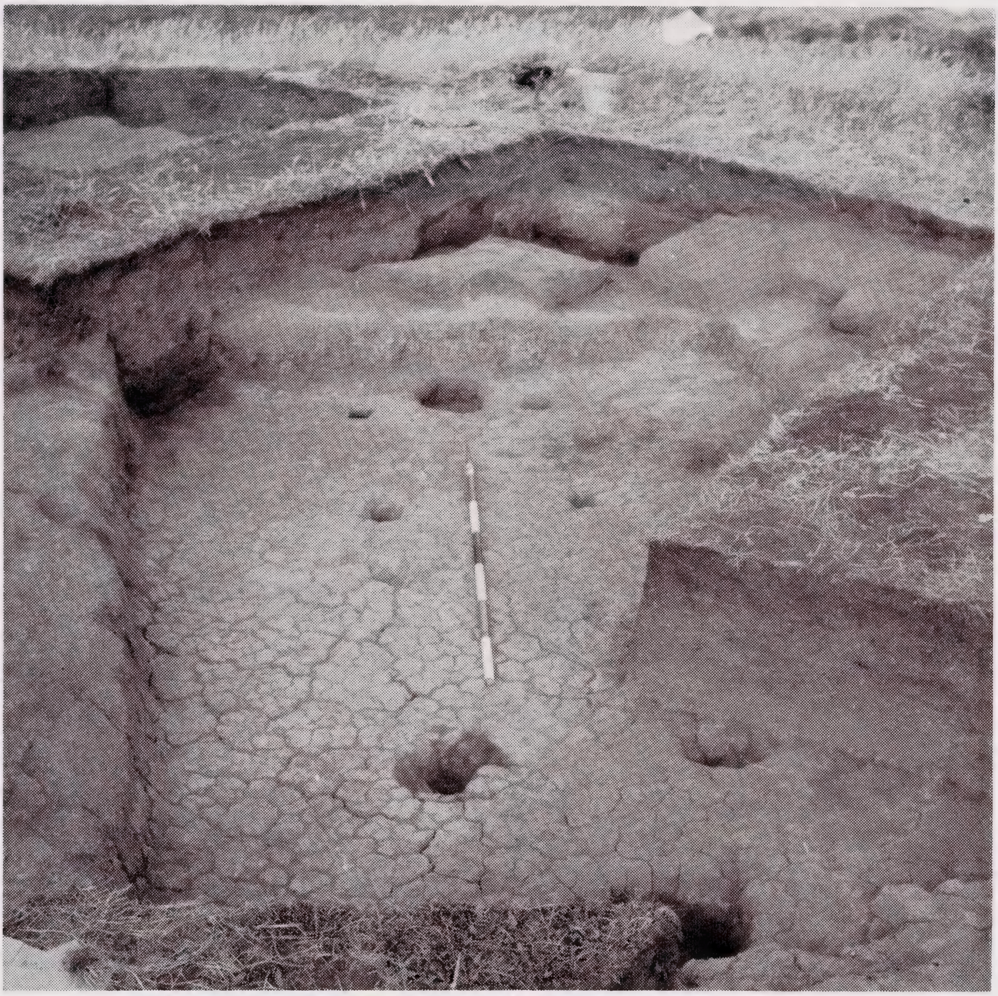

FIG. 9. Pit 4, N38/37, from the south-east.

Pit 5 was aligned with structure C in such a way as strongly to suggest their contemporaneity (Fig. 10). It was a deep rectangular pit (nearly 1 m deep) with an end buttress at the excavated end, and a drainage channel which actually ran out through a tunnel in one corner, and appeared to link up with the open drain from structure C. The deepest portion of the floor was at the north-east corner; i.e., at the present time the drain runs into, rather than out of, the pit although the difference in level is very slight.

FIG. 10. Pit 5 and structure C, N38/37.

Only a corner of pit 6 was uncovered. It appeared to be a rectangular pit with a slightly undercut rim. The fill was a mixture of soil with scattered midden and lumps of clay.

The surface of the two areas represented by the 8 row of squares and the K row of squares suggested an identical type of disturbance. Excavation revealed that this was not the case. Whereas the differential growth of vegetation on the eastern slope did indicate the presence of structure C and pit 5, the identical effect on the northern slope was caused by the presence of a terrace, rather than a pit. In squares N-8 and O-8, a cut back into the natural slope resulted in the removal of layers C and D from the area and the construction of a flat terrace (Fig. 5). The purpose of this terrace is not clear. A few shallow slab-like postholes suggest the presence of some kind of structure, possibly a house. The curious disturbance shown in the section was thought

at first to be a cultural feature, but we later concluded that it was probably caused by an uprooted tree before the construction of the terrace.

In two other areas artificial levelling of the site had apparently taken place. In the vicinity of structures A and B the ground had been levelled by the removal of layers C and D to form a platform. Whether this levelling took place at the time of the construction of structure D or that of structures A and B is uncertain. As the levelled area coincided neatly with the area of structures A and B, it is probable that it dates to the time of their construction. On similar grounds it could be argued that pits 2 and 3, also fitting on the same cleared area, belong to the same construction period.

The possibility that the levelling of the area took place after the abandonment of structures A and B can probably be discounted on the grounds that the infilling of structure A suggests that no further activity took place on the site after its abandonment. On the other hand, the possibility that the levelling truncated or removed earlier structures in the same area is suggested by a 25 cm deep posthole and traces of a slot or drain on the slope behind structure B.

Another area where levelling probably took place is in the vicinity of pit 5 and to a lesser extent structure C, both of which seem to have been dug into an area previously cleared of Rangitoto ash. Similar levelling may have taken place in the area of pit 6, and a suspected unexcavated pit in the area of grid square I-12. No structural evidence was encountered in square I-13 which, however, revealed a surprising depth of disturbed soil and midden apparently derived from cultural activity further up slope. This deposit reached a maximum depth of 50 cm in the north-east corner of the square.

A few postholes in addition to those in the structures and on the terrace were found. Several postholes filled with layer B deposits were found in the flat area between structure A and pit 4, which may be contemporary with pit 1. Their significance was not apparent.

Postholes also occurred in square N-10, suggesting some kind of structure in the cooking area. The nature of such structure or structures could not be inferred from the few postholes uncovered. One posthole in this area was thought by its excavators to be earlier than the Rangitoto ash. It was filled with a mixture of ash and clay and occurred in an area where the ash mixed and merged with later midden deposits in a rather confusing way. The age of the posthole is therefore doubtful. It is the only feature found which may antedate the ash. It should be noted, however, that the ash was not excavated in many areas of the site, so that it is possible, though unlikely, that other features lie concealed beneath it. The location of features beneath the ash anywhere on Motutapu would be dependent on extensive test boring or mechanical excavation.

Burial

A burial was encountered in the north-west corner of square M-8 extending under the baulk M-8/N-8 (Fig. 11). The skeleton, in good condition, was that of a mature individual, probably female. The burial was placed in a thick layer of

Rangitoto ash and covered with similar material, which accounts for the excellent state of preservation. No grave was discernible, and it is assumed that the body was placed in a scooped depression and covered immediately with the material excavated from the depression. The body lay on its right side, oriented towards the south, but facing east. It was flexed, and in a more natural position than the flattened skeleton from site N38/30. There were no grave goods.

For cultural reasons, this image has been removed.
Please contact Auckland Museum for more information.

FIG.11. Burial, square M-8, N38/37.

There is no indication of the time during the site's history when the burial occurred. It could be associated with any of the other features. The presence of a burial in N38/30 more closely related to the occupation of that site indicates that burial in or near settlements may have occurred on Motutapu in the past without necessarily requiring the abandonment of the site.

Although no other burials were found, a portion of human tibia occurred in the topsoil covering structure C. This was not a midden area, and the possibility that the bone derives from past disturbance of another burial somewhere in the upper part of the site is suggested.

Occupation Sequence

Three separate stages of occupation or use of square M-10 could be identified, and two of L-9. In other areas there was evidence for only one activity, and correlation between areas could only be inferred.

The first evidence of use in M-10, and probably in the entire site, is pit 1, with which no other features are certainly associated.

Only a brief period appears to have elapsed between the abandonment of the pit's original function and its use for a cooking area, as there is only a slight deposit of natural infilling in the base of the pit. On the other hand, the possibility that it was cleared out for use as a cooking area or, more probably, that a roof over the abandoned pit retarded the rate of natural infilling, is suggested by the nature and depth of fill in the drain in M-11. Most of the pit fill consists of a build-up of cooking deposits.

No stratigraphic grounds exist for correlating the cooking deposits in pit 1 with other activities on the site, but it is unlikely that there were no other activities taking place at the time. The structures A and B could be associated, or the earlier structure D. The latter, however, could equally be associated with initial use of pit 1. The strong possibility that evidence of occupation in squares L-9 and M-9 was destroyed during the terracing and construction of structure A and B must be admitted.

Thirdly, in M-10, two more rectangular pits were constructed, aligned almost at right angles to pit 1. The associations of these pits, too, depend on inference rather than direct evidence.

New Zealand archaeology has become conditioned to the assumption that two pits are often associated, aligned along a single axis (Parker 1960, Golson 1961). Consequently it is easy to assume in this case, too, that pits 2 and 3 are associated with structures A and B. There are some grounds for making this assumption, however, if we assume that structures A, B and C are contemporary on the grounds of similarity to each other, and difference from pits 1 and 4, which are probably earlier and later respectively. In the case of structure C and pit 5, the conclusion that they are meaningfully aligned is unavoidable; both are on the same terrace, in an area of the site where there appears to be no other occupation, and the alignment is identical. The assumption that structure C and pit 5 are contemporary makes it easier to assume a similar relationship between structures A and B, and pits 2 and 3.

On the grounds of alignment, pit 6 and probably another unexcavated structure aligned with it, would also be associated with this group. The position of the terrace on the northern slope cannot be determined stratigraphically, and may be assigned to this or other stages with equal reason.

The only remaining structure to be discussed is pit 4. There is no doubt that pit 4 is later than pit 1 on stratigraphic grounds, and some slight evidence that it is later than pit 2 on the basis of some fairly complex local stratigraphy in the area of the baulk L/M-10 (Fig. 5). Its different nature and alignment from other features inclines me to this interpretation, although it could acceptably be interpreted as contemporary with structures A and B.

Another factor to be considered is the fill of the various pits. On this basis, structure A, C and pit 4 all rank late as having filled largely by natural means after abandonment of the site. Pit 5, which has a complicated fill of clay lumps and other lenses, was almost certainly filled quickly and deliberately. This means it could still have been contemporary with structure C, despite their different fills and could, indeed, have been filled with spoil dug out of pit 4, if this indeed was later. The difference in fills between pits 2 and 3, structure B and structure A, is stronger

evidence against their contemporaneity. The fills of the pits could have been the result of the continuing popularity of this area of the site as a cooking area. The difference of fill between structures A and B will be discussed in the section on interpretation.

Taking all factors into consideration, I am inclined to propose the following succession for the site:

1. Construction of pit 1 and its use for purposes other than cooking. Other activities not known.

2. Use of abandoned pit 1 for cooking, probably associated with structure D and other activities or structures in the area of structures A and B now destroyed by later activities. Portion of a drain at the south-western end of structure B could be a remnant of an earlier truncated feature. The terrace on the northern slope may also belong to this period.

3. Construction and use of structures A, B and C associated with pits 2, 3 and 5, and pit 6 probably associated with another structure or pit in the unexcavated area. The terrace on the northern slope more probably also belongs to this time. Cooking and dumping activities continued in the north-eastern corner of the site.

4. Construction and use of pit 4, perhaps associated with further cooking and dumping activities in the area of M-10 and M-11, and possible continued use of structure B and the terrace.

From the foregoing discussion, it will be apparent that this is merely what I consider the most economical and satisfactory explanation of the evidence; other alternatives could be chosen.

Faunal Remains

An attempt was made to collect all midden material from the excavated area. All substantial pieces were collected, but the deposits were not sieved, and many small fragments of shell and bone must have escaped the patience of the excavators. Only in M-11 was a definite decision made not to collect all faunal material; here, more concentrated deposits of shell middens were found, and a single large sample was taken in the area where they occurred. The midden analysis is the subject of a separate paper (Allo, this volume). Here, it should merely be noted that the midden material represents deposits associated with occupations 2, 3 and 4; the only occupation for which no midden was present being period 1, represented by pit 1. No obvious differences in content in the different midden deposits were noted, and because of the difficulty of confidently identifying deposits of different ages, the midden was treated as one assemblage. This can be justified on the grounds that individual layers and areas show little or no difference from other layers and areas.

Artifacts

Sufficient artifactual material was recovered from the site to indicate that a range of activities was being carried on there. Very much less was recovered from

TABLE 1

DISTRIBUTION OF ARTIFACTS IN N38/37

ARTIFACTS	EXCAVATED SQUARES																										
	N-8	N-8 ext.	N-10	M-8	M-8/9	M-9	M-10	M-9/10	L/M-10	L/M-9/10	M-11	L-8	L-9	L/M-9	L-9/10	L-10	K/L-10	L-10/11	L-11	K-10	K-11	K-12	K-11/12	J-11	J-13	I-8	I-13
Obsidian																											
grey	29	19	2	12	2	13	—	1	1	2	1	1	5	1	—	1	—	—	—	3	1	1	1	7	1	—	—
green	5	2	—	1	—	1	—	—	2	—	—	1	3	—	—	—	2	—	—	4	—	—	1	4	2	—	—
Greywacke																											
flakes	6	—	—	6	1	17	2	—	1	—	—	—	2	—	2	4	4	1	—	10	5	4	—	7	4	—	4
chips	2	—	—	2	—	3	1	1	—	—	2	—	—	—	—	4	2	—	—	2	3	—	—	6	1	—	—
Chert																											
flakes	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—
chips	—	—	—	2	—	2	—	—	—	—	2	—	1	—	—	—	1	—	—	—	—	2	—	1	8	—	1
Adzes																											
complete	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—
rough out	x	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	x	—	—	—
chip	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	x	—	—	—	—	—	—	—	x	—	—
hammerstone	—	—	—	—	—	x	—	—	—	—	—	?	—	—	—	—	—	—	—	—	x	—	—	x	—	—	—
grindstone	—	—	—	—	—	—	—	—	x	—	—	x	—	—	—	—	—	—	—	—	—	x	—	—	?	—	—
burnisher	—	—	—	x	—	—	—	—	—	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—
hone	—	—	—	x	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	x	—	—	—	—	—
core	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	x	—	x	—	x	—	—	—	—	—	—
chopper	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bone artifact	—	—	—	x	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

x = present

this site, however, than from the smaller area excavated at N38/30. The artifactual material falls into several main categories. Only two bone artifacts were recovered, a tattooing chisel, and a piece of worked bone that may be intended for an ornament. No shell artifacts were identified, although an *Amphidesma australe* shell full of fish scales, which had obviously been used for scaling fish, was found in the midden in square M-11. There is a substantial assemblage of obsidian. The remaining artifactual material consists of adzes and items associated with their manufacture, and stone flakes. The horizontal distribution of artifacts in the site is shown in Table 1.

TATTOOING CHISEL

A small bone tattooing chisel, AR 910, was found in the fill of structure B in square M-8. It is a flat straight-sided piece of bone, 2.2 cm long (from the butt to the beginning of the teeth) and .7 cm wide. The butt end is straight except for an indentation apparently resulting from a former perforation. There is a perforation in the centre a few mm in from the butt. The teeth are broken, which is probably why the chisel was discarded. In the area where they are still measurable there are 3 teeth to a space of 4 mm.

WORKED BONE

Also in the fill of structure B, in the baulk of M-8/M-9, was a small worked piece of bone, AR 921, apparently fish bone. It is flat and thin, 2.9 cm long and 1.5 cm wide at one end, tapering to a point at the other end. It has been cut from a larger piece of bone by sawing across the wide end. Whether it is a waste piece from the manufacture of some unknown object, or whether it is an incomplete item intended as an imitation shark tooth, for instance, is not clear.

ADZES AND ADZE FRAGMENTS

The only complete adze from this site, AR 1047, was found in the fill of structure C, lying near a patch of reddish wood ash at the top of the fill. Its position indicated that it had been deposited after the abandonment of structure C, so that it cannot be regarded as clearly associated with occupation of the site. This adze (Fig. 12a) is 16.3 cm long, 5.6 cm wide and 3.0 cm thick at the centre. Its maximum width at a point about one-quarter of the total length from the cutting edge is 6.0 cm. It has a rounded quadrangular section, and no butt modification. The surface is hammer dressed all over, while only a portion of the front, and the bevel, show signs of grinding. The adze was, however, evidently considered usable, for the cutting edge shows signs of wear. In shape, the adze is close to Duff's type 2B (Duff, 1959, p. 133). In finish, however, it belongs to the same tradition as adzes from N38/30.

The butt end of an uncompleted triangular sectioned adze, AR 941 (Fig. 12c), was found in the midden and cooking layer in square N-10. Alone of the adzes from this site and N38/30, it is not made of local greywacke. The length of the portion recovered is 6.7 cm and the width and thickness at the broken portion are 4.8 and 4.0 cm respectively. In section, this fragment is of undeniably Archaic appearance. Its position in the site, however, suggests possible use as a *haangi* stone, so that its Archaic affiliations may be misleading.

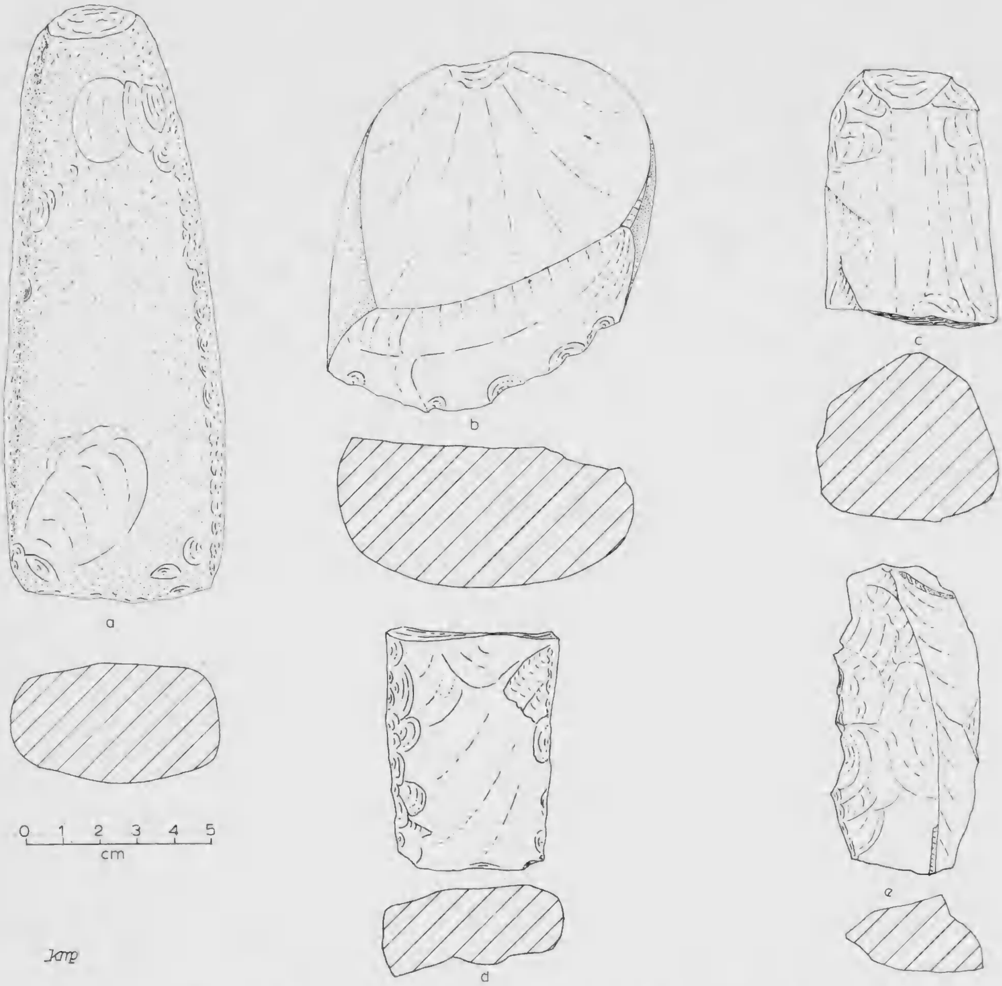

FIG. 12. Stone artifacts, N38/37: a. adze, AR 1047. b. pebble chopper, AR 893. c. portion of triangular-sectioned roughout, AR 941. d. broken roughout, AR 881. e. possible roughout, AR 1037.

Two broken central sections of roughouts were recovered from square J-11. Both are in local greywacke, and exhibit the kind of flaking technique most commonly associated with the manufacture of Archaic adzes. AR 1065 was found in the soil layer outside the area of pit 5, and appears to be part of the roughout of a thick quadrangular adze, almost as thick as it is wide. Deep in the fill of pit 5, as part of the deliberate infilling, was AR1074, a rough central section of a wider, thinner quadrangular-sectioned roughout. Both these items were poorly flaked and showed no signs of hammer dressing.

A portion of a better made and more advanced roughout, AR 881, was found resting on the terrace in square N-8 (Fig. 12d). It may be either the butt or blade of a rectangular-sectioned roughout, which had been shaped by flaking, and was being hammer dressed when it broke and was discarded.

One other item that may be an adze roughout was found lying on the Rangitoto ash layer in square K-11. It is a small blade-like core (Fig. 12e) which has no evidence of hammer dressing, but could be the roughout of an adze similar to the smallest recovered from N38/30.

Several small chips which seem to be from complete adzes were found and include examples from layer A in J-13 and L-9 and the fills of structure A and pit 4. These may indicate the actual use of adzes on the site.

The adze fragments most closely associated with occupation of this site are all roughouts made in local greywacke by flaking and, in one case, hammer dressing. The techniques used recall those used by the occupants of the Pig Bay and Sunde sites. The shapes, however, seem to be quadrangular, and generally lacking in butt modification. The complete adze, while probably also made by the same techniques, is definitely 2B in type, while the only unquestionably Archaic specimen may not have been part of the adze kit of the site's occupants.

HAMMER STONES

That hammer dressing of stone took place on the site is evidenced by three well-used hammer stones. AR 1038 was found resting on Rangitoto ash in square K-11. It is a rounded, fist-sized, water-worn pebble of fine-grained stone, probably greywacke, which exhibits bruising on one end. Its maximum diameter is 8.1 cm and minimum 6.2 cm. A similar but more oblong pebble of the same type of stone, which had no sign of use, was found in the topsoil on the slope behind structure A in the excavated portion of square L-8.

AR 925 was found in square M-9 and was probably associated with the use of structure B. It is a roundish flat disc-like pebble with extensive bruising all around the circumference. Its maximum diameter is 7 cm and maximum thickness 3.3 cm. AR 1066 is a broken pebble of a local green chert. One end has been used as a hammer. This stone was found lying outside pit 5 in square J-11. Several chips of similar stone, which appear to be fractured bits of hammer stones, are described below in the section on flakes.

No hammer stones of jasper were found in this site, in contrast to N38/30. AR 1038, 984 and 925 appear to be local greywacke, while AR 1066 is also a local stone.

GRINDSTONES AND BURNISHERS

Although only one partly polished adze was found in the site, several pieces of grindstones and other abraders were found, indicating that activity on the site probably included the sharpening of tools. A broken grindstone, AR 985, was found in L-8 on the slope above structure A. It is a flat stone with a smooth depression on one surface resulting from its use as a grindstone.

Two smaller fragments which are probably also from grindstones are AR 1046 from the fill of structure C and AR 980 from the fill of pit 1 in the baulk L-10/M-10. The latter may have been used as a *haangi* stone. Each of these three stones appears

to be of volcanic origin, possibly basalt, and would not occur naturally on Motutapu. A flat piece of sandstone, which would be suitable for grinding, but had not been used, was found in layer A in square J-13. It, too, must have been brought to the site deliberately.

Several small stones with one or more highly polished surfaces seemed to have been used for burnishing or polishing, although they might have been used for working wood rather than stone. AR 1080 was found in layer A in square J-13, and AR 902 in layer A in M-8. A more doubtful example, AR 966, was found in layer B in M-11. In several areas of the site, soft pebbles of mudstone were found which had grooves, apparently made by honing. They were found in layer A in square M-8 and L-9, and against the wall of structure C. It is possible that the grooves are natural rather than artificial.

GREYWACKE FLAKES AND CORES

In view of the presence of hammerstones and grindstones in the site, the small number of stone flakes was surprising. It seems that such adzes as were brought to the site were ready for hammer dressing, and that little or no rough shaping of adzes was done there. Only a small number of flakes showed signs of use; the scattered distribution of the remainder throughout the site gives little clue of the reason for their presence.

All pieces of greywacke saved as flakes during the excavation were inspected during analysis. Quite a number were found to have no identifiable striking platform or bulb of percussion, and seem to be broken pieces of larger flakes. These were not measured, as there was no means of ascertaining their correct alignment. Those which were identifiably flakes were measured following the alignment suggested by Shawcross (1964b). The presence of weathered cortex, or a water-worn surface, was noted and also signs of use, or marks of hammer dressing. Of the total collection of 109, 29 were found to be chips, that is, they lacked identifiable striking platforms. They did exhibit partial flake scars, however, and appear to be broken flakes rather than natural spalls. One had an area of cortex, and two had one water-worn surface. None showed evidence of use or hammer dressing. Of the 80 flakes, 14 had traces of cortex and 13 traces of a pebble surface. Eight of the 80 had signs of use, on at least one edge, that were visible to the naked eye. This visible use mark consisted of tiny chips, sometimes accompanied by a patina or polish. Experiment revealed that greywacke flakes could be used for cutting soft material (such as the investigator's finger) without leaving any visible sign of use on the edge, suggesting that most flakes could have been used for purposes such as food preparation, and that only those employed in working harder material show visible signs of use. Five of these were used along an edge formed by the junction of a pebble surface and a flake surface. They had evidently been struck directly off a pebble. Two of the five showed bruise marks around the striking platform, as though several attempts had been made to dislodge the flake. The other three flakes showing use marks included two flakes with cortex, one of which also had signs of bruising, and a flake from a hammer-dressed adze. The only other flakes worthy of comment were one with pebble surface, and one ordinary flake, both showing signs of bruising.

All identifiable flakes were measured. Only length-breadth dimensions were taken; angle of striking platform was not considered. In Fig. 13, the number of flakes falling into each 5 mm square is shown. The total flake collection shows a considerable size range, and a tendency for flakes to be greater in width than in length. The flakes with some area of weathered cortex visible follow the general flake pattern in tending to be wider rather than longer. Those with a pebble surface, however, tend in the other direction. Flakes with pebble and cortex surfaces tend to be larger than average.

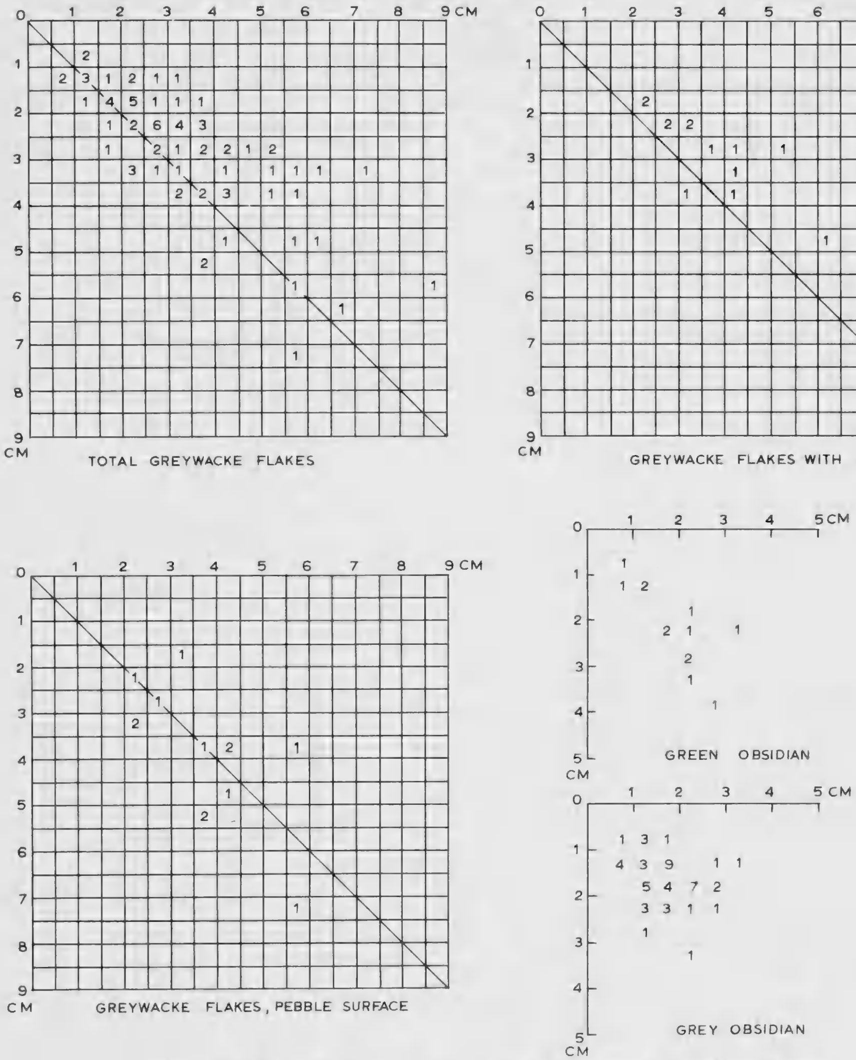

FIG. 13. Measurements of obsidian and greywacke flakes, N38/37.

Several cores or pieces of greywacke were found. Three pieces of similar size to the largest of the flakes were found in M-11 in the midden, in the fill of pit 4, and in layer A in K-11. A larger core with a small area of pebble surface and a number of flake scars was found near the surface of L-11.

A large smooth water-worn stone was found resting on the subsoil outside structure C. The purpose for which it was brought to the site is uncertain.

A crude pebble chopper was found in N-10 in the midden layer. It was formed by breaking a water-worn pebble, or striking a flake off it, and then dislodging a second flake which removed the original bulb of percussion. The removal of the second flake resulted in a remarkable flake scar (Fig. 12b). The edge where pebble surface and original flake scar meet shows signs of extensive use.

During excavation, a number of pieces of the chert from which the hammer stone AR 1066 was made, were collected. Of a total collection of 25 pieces, only five were found to be true flakes. Four of these, and 17 of the total collection, were from the exterior portions of water-worn pebbles. One of the flakes and two of the other pieces showed extensive bruising, and are probably from hammer stones. Despite its promising appearance, this type of stone does not flake well. The explanation for many of the pieces found in the site may be their derivation from hammer stones.

OBSIDIAN

One hundred and thirty-two pieces of obsidian were found. Of these, 28 showed a greenish tinge when held up to the light, and are assumed to be from a Mayor Island source. The remaining 104 are grey, although there is considerable variety in their opaqueness, and a few pieces have a pinkish tinge. It is hoped to have a representative sample of obsidian from this site analysed for its sources, and measured for the development of hydration rims.

The distribution of obsidian as well as other items in the site is shown in Table 1. From this it is evident that the bulk of obsidian was found on the terrace in N-8 and the vicinity of structure B.

The obsidian was divided into four main categories. Flakes included only those on which a complete flake scar and bulb of percussion could be identified. Chips are apparently broken flakes, being normally thin, and exhibiting a portion of the flake scar. The term core was restricted to small cores which have numerous small flake scars, and could not provide further flakes. These were originally considered to be discarded cores, but their small number, similar appearance, and the presence of use marks on some of them suggest that they may have been some kind of tool in themselves. The remaining category, designated pieces, included items with parts of several flake scars which, however, lacked the completely flaked appearance of cores, while being more substantial than chips.

All items were inspected for evidence of use or secondary flaking, the presence of hinge fractures, the presence of the bubbly surface characteristic of the edge of an obsidian flow or boulder, and any combinations of these factors. The numbers in each category are given in Table 2 for the whole assemblage. The distribution of different categories in the site was not remarkable. Flakes showing use, however, were not concentrated on the terrace and structure B to the extent that total numbers of obsidian items were.

Five items deserve special mention. These are derived from water-worn obsidian, and include two fresh flakes, a fresh chip and a fresh piece from larger water-worn

TABLE 2

ANALYSIS OF OBSIDIAN FROM N38/37

		GREY	GREEN
FLAKES	ordinary	24	7
	with use marks	7	5
	external boulder surface	14	0
	external boulder surface and use marks	1	0
	hinge flake	4	0
	hinge flake with use marks	1	0
CORES	ordinary	3	1
	with use marks	2	0
	external boulder surface	3	0
	external boulder surface and use marks	2	0
PIECES	ordinary	9	5
	external boulder surface	11	0
	external boulder surface and use marks	1	0
	scar of hinge flake	1	0
	scar of hinge flake and use marks	1	0
CHIPS	ordinary	14	5
	with use marks	0	2
	external boulder surface	2	0
	part of hinge flake	2	0
WATERWORN	flake	1	0
	flake with use	0	1
	core with use	1	0
	chip with use	0	1
	piece	0	1

pieces or cores, and a water-worn piece with fresh small flakes on one edge. One of the flakes and the chip show signs of use. Two of the items (one flake, and the piece) are grey and come from the terrace, while the remaining items are green and were found in K-10 and J-11.

So far as can be ascertained, the parent materials in all cases were water-worn artifacts, rather than natural pebbles, suggesting that they were collected from a beach where they had eroded from an abandoned site. The fact that both green and grey obsidians are represented tends to reinforce this view.

The chronological relationships within the obsidian assemblage are doubtful, but it seems likely that almost all the assemblage belongs to the postulated occupations 3 and 4, as no obsidian at all was found associated with pit 1 or its infilling. The heavy preponderance of grey obsidian in the total figure for the site is due to the large quantity recovered in the vicinity of the terrace and structure B. The working of a single smallish lump of grey obsidian in this area could be responsible for this. The proportions of green and grey are more even in the rest of the site and it appears that the occupants were obtaining obsidian from at least two different sources.

DISCUSSION

The total evidence from this site shows that a wide range of activities were carried out including not only the construction and use of pits, but the preparation, cooking and eating of marine, and presumably also vegetable food, and the finishing, use and probably repair of stone tools. It can thus be seen as a true undefended settlement, where a variety of domestic activities took place.

The evidence recovered from the site, however, does not easily lend itself to interpretation in specific terms relating to definition of domestic and communal units as outlined by Groube (1965), largely because of the lack of adequate stratigraphic evidence for determining which of the structures in the site are contemporaneous. Moreover, the function of the structures is in some doubt.

With the beginnings of systematic stratigraphic excavation in the Auckland Province, claims that pits were used both for dwelling and habitation were advanced for such sites as Skipper's Ridge (Parker 1960), Kauri Point (Golson 1961) and the Kauri Point undefended site (Green 1963b) with the further suggestion by Parker (1962) that at Kumara Kaiamo in North Taranaki, sunken houses were replaced by surface dwellings characterised by the rectangular stone hearth. The assumption that pits were ever used for dwellings has been challenged on many grounds during recent years, while those who argued most strongly in favour of the existence of sunken dwellings are no longer actively concerned in the investigation of New Zealand prehistory. Principal arguments against the existence of sunken dwellings have included the remarkably clean interior of most excavated examples, and the unnecessary clumsiness of a hypothesis which postulates the initial introduction of a surface house (which continued throughout the prehistoric sequence of much of the South Island), its replacement at a fairly early date by a sunken house, and the subsequent reversion to a surface house commonly described in the Proto-Historic Period (Groube 1965). The major argument in favour of sunken houses, the absence of excavated evidence for surface houses, is now being overcome by their discovery in a number of sites, including two reported in this volume (Leahy, Davidson, following papers).

Even so, the question is still of such importance in the interpretation of New Zealand prehistory that it is worth taking a further look at some of the issues involved. The first point is that what is under consideration is not a true "pit house" but merely a structure whose floor may be sunk as little as 30 to 50 cm below the ground surface, and usually less than one metre. Secondly, although food pits of various kinds have been excavated in tropical Polynesia, these are mostly of the small bin or *rua* type. The change from this type of storage to the larger rectangular roofed structure so frequently encountered in New Zealand is a fairly major one. Modern examples of sunken *kumara* stores still existing in parts of the Auckland province indicate that they could be perfectly acceptable dwellings, and it seems unwise to suppose that such structures were never so used. Indeed, on present evidence it is difficult to say whether the initial step was from a sunken house to a sunken store of rectangular rather than bin type, or the other way round. Although evidence is now rapidly accumulating concerning houses and domestic and communal units in the Classic Maori phase, the same cannot be said of earlier phases, where

attention appears to have reverted to artifact collecting. There is still little evidence for the nature of houses in earlier phases. The argument that the sunken house does not occur at all in the far south may merely mean that an initial adaptation to pits for both storage and dwelling may not have penetrated so far.

A feature of the surface house that Groube claims as almost universal is the stone hearth. Such hearths are lacking, however, not only from N38/37, but from recognisable surface houses at N38/30 and Hamlins Hill (N42/137), although in the latter case hearths could have been destroyed by later activity on the site. On the present evidence, the stone hearth was not an essential feature of houses in the Auckland area, although it is recorded for Mt. Roskill, suggesting that, as the ethnographic evidence cited by Groube implies, house styles may have varied considerably.

The principal problem in the correct interpretation of N38/37 is understanding the function of the structures. This is fundamental to any elucidation of the settlement pattern or inferences concerning the group of people responsible for the site, although external comparisons can be based purely on structural evidence.

The most telling argument against the use of pits for dwellings is the absence of domestic litter in association with many of them. Presence or absence of hearths, even size, appear less certain indicators. In terms of this criterion, the only convincing candidates on this site for consideration as dwellings are the terrace in N-8, and structure B. In both these areas, a sufficient amount of domestic debris occurred to suggest residential rather than other functions. This immediately raised the question of the separation of structure B from the closely similar structures A and C. The possibility of alternate uses of structures appears the most satisfactory explanation for this apparent dichotomy; the possibility that structure B, designed like its fellows as a storage unit, was subsequently converted into a dwelling, must be considered.

The general absence from other structures of domestic litter in primary association, is a major argument for accepting them as storage pits, despite their range in size and form.

Pit 1 is basically a rectangular pit of a kind widely revealed by excavations in the Auckland province, namely a rectangular pit with a single central line of postholes and no buttresses. The curious drainage system is probably unique, although the concept of a curving floor drain running out through a slit in the downslope longitudinal wall near one end recalls pits at Sarah's Gully (Golson 1959: plate I). Pit 2, from the portion of it uncovered, appears to belong to the same general type, although it is smaller and shallower. Two central postholes are probably part of a row of three. In addition to the lack of litter on the floor, this pit is almost certainly too small for a dwelling. The nature and function of pit 3 is slightly more obscure as no postholes at all were found in the excavated portion. The pit was not completely excavated, however, while it is quite possible that a posthole dug not into natural clay, but into the underlying fill of pit 1 was missed. The size and shape of pit 3 also tend to suggest a storage function.

Storage can less certainly be inferred for pits 5 and 6. In the case of pit 6, so small an area was excavated that details of the pit's size and superstructure are lacking. The limited evidence available, however, suggests that this pit may have

close parallels with pits 2 and 3. Pit 5 is deeper than the other pits and the excavated portion lacks postholes. But the pit is deep enough for a flat roof to provide adequate covering. This pit has the most pronounced buttress of the structures at this site, although vestigial buttresses appear at one end of structures C and A. An end buttress was also found in the pit at N38/30, and the feature seems widespread in the Auckland Province (cf. Shawcross 1966, pp. 66-67). The drain running out through a tunnel in one corner is known from some other sites in heavy clay, notably Taniwha Pa and the small site N30/3 at Harataonga Bay, Great Barrier Island.

Pit 4 is by far the largest pit in the site, and on the basis of area could well be considered a house. The absence of domestic litter again militates against this interpretation, while the smaller postholes possibly belonged to a rack of some kind. Again, a storage function, possibly of a rather different order from the other pits, is indicated.

The most difficult features to interpret are structures A, B and C. Structure D is too vestigial for an interpretation to be attempted. The similarities between the three former structures are several, but at the same time their differences are noticeable. Structure A is similar in depth to pits 2, 3 and 6, but structures B and C are shallower, although equally shallow pits in other areas have been acceptably interpreted as storage pits. The three structures provide an interesting example of variability, for they may be presumed to be contemporary, and constructed by people who shared the same building tradition. Yet, there are more points of difference than similarity, illustrating the dangers of comparing similarities between structures from widely separated sites on the basis of small samples.

The concept of the pit dwelling aligned with storage pit, first suggested for Skipper's Ridge and Kauri Point, dies hard. The temptation to interpret these three shallower structures as house sites aligned with deeper, less elaborate storage pits is strong. Only structure B, however, contained on its floor the sort of debris to be expected on a house floor, and it seems far more likely that all three structures were designed as storage pits, and one was subsequently converted into a dwelling.

If pit 1 is interpreted as a storage pit, we may assume that the initial use of this site was by an agricultural group. At this stage, as far as is known, the site was purely a storage area, and may not have been inhabited at all. Throughout the remainder of its history, however, it appears to have served both domestic and storage functions.

The exact constitution of the site at any one time must be in doubt. The maximum number of structures in use at a time would be three and probably four pairs, namely structures A, B, C and pits 2, 3, 5, plus pit 6 and its inferred companion. If these are all storage pits and contemporary, the reasons for their internal differences are difficult to explain. Moreover, the location of houses to accommodate the people who built the pits and left the cooking and other debris scattered around is rather a problem. The terrace probably accommodated a flimsy structure, and others could have existed in the area of pit 4 and around the fringes of the site. Under these circumstances, although planning is evident in the general layout of the site, separate domestic units within it cannot be identified; rather the domestic, communal and

probably economic units, while the site was occupied, appear to coincide. This situation is in marked contrast to that observed at N38/30, where a minimal domestic unit could be clearly identified.

If pit 4 is also assigned to this time, it must be viewed as a communal house or store, of a different order than the other pits; if it is later, perhaps contemporary with the re-use of structure B, it may indicate a change in the composition of the group occupying the site, or a change in attitude towards storage techniques.

Concurrent with the dispute about the function of pits, a doubt has developed concerning the usefulness of pits for typological analysis (Shawcross 1966, Terrell 1965). It has become increasingly clear that they are too variable to be used in far-reaching comparisons. On the other hand, there have been few sustained attempts to document their range within a small defined area from the results of a number of excavated sites. The investigation of New Zealand prehistory has now reached a stage where the need for well-documented sequences from small areas has become increasingly apparent. While general comparisons with sites far from Motutapu are interesting, it will be more important to compare the results of this site and N38/30 with results from other sites in the immediate area, and endeavour to build up some kind of relative time scale in which these sites can be placed. It is hoped that such a time scale can be provided by the use of both obsidian and radiocarbon dating methods. The presence of floor drains running into sumps or tunnels, and end buttresses, together with the central posthole pattern are features known from other sites, and may eventually prove to be significant. Drains, however, can only be expected under certain conditions, and care must be taken to compare pits dug in similar soils before pondering too deeply the differences and similarities between pits in widely differing bedrocks.

The age of this site, and its temporal relationship to other excavated sites on Motutapu are not yet known. The limited material culture recovered is not convincingly Archaic; nor is it as uncompromisingly Classic as that recovered from sites such as Waioneke at South Kaipara or various Waikato sites. It could well be assigned to a Motutapu Aspect of an Early or Proto Maori phase. The economy of the group occupying the site, however, is typical of what we know of Classic Maori, being apparently dependent on agriculture and fishing. The use of predominantly local rock, but access to two sources of obsidian, also suggest a proto Maori phase.

If, as Golson and Green suggest, Motutapu was a rather "backward" area, the site could still be a very late one. The likelihood that it was occupied during the latter part of the sequence recorded from Pig Bay and the Sunde Site seems strong. Until the full details of the former site, particularly, are available it is impossible to say what similarities in material culture, if any, exist between the two sites.

N38/37 can justifiably be regarded as an undefended settlement. As it is based upon storage pits, the principal occupation may have been only one season's duration. The extent to which the occupants exploited a far larger territory than Motutapu cannot be guessed until further excavations in surrounding areas are undertaken, although it is worth noting that the pits excavated at Alberon Park and Hamlins Hill do not appear to be the work of exactly the same group. Similarly, until excavation of a fortified site on Motutapu is undertaken, the relationship between defended and

undefended sites must be doubtful. I am convinced, however, that questions of settlement pattern and sequence in the prehistory of the Auckland Province will now be solved only by continuing and intensive investigation of numbers of sites in selected areas.

CONCLUSIONS

The excavation justified the recording of vague surface features on Motutapu Island as archaeological sites, but revealed that pits and terraces can present identical surface evidence. This site, which had been recorded as "pits/terraces", was shown to be an undefended settlement containing extensive remains of cooking and working, as well as food storage. It is thus most comparable to Skipper's Ridge[1], at Opito, where cultural debris was also associated with pits, rather than the Kauri Point "Undefended Settlement", or the nearer Alberon Park site, where occupation debris was lacking.

Several successive occupations were in evidence, probably each of only one season's duration. A number of subsurface structures in patterned arrangement are interpreted as storage pits, although one appears to have been subsequently used as a dwelling. Otherwise, evidence of house structures is very slight, and they are presumed to have been insubstantial. The group occupying the site was larger than a nuclear family, but appears to have constituted a domestic unit, in so far as there was a single common cooking area. Nonetheless, the group involved was significantly larger than that responsible for the domestic unit at N38/30, or the storage component at Alberon Park.

Until an indication of the age of the site is available, its relationship to other sites is uncertain. On cultural grounds, it is assigned to a Motutapu Aspect of Early Maori Phase, recognising that this may be later in time than Classic Maori in some other areas.

ACKNOWLEDGEMENTS

The excavations on Motutapu were made possible by the interest and co-operation of the Lands and Survey Department, particularly the Commissioner of Crown Lands, Auckland, and the Supervisor of Land Development, Whangarei. The Farm Manager on Motutapu and his staff were also co-operative. I am grateful to all who took part in the excavation, and those who arranged the purchase and dispatch of supplies from Auckland. Above all, I am grateful to Anne Leahy who organised the camp as well as directing the second excavation.

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1 Here, I am referring to the site, Skippers Ridge I, excavated by Parker, rather than that which Bellwood recently excavated and designated Skippers Ridge II.

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EXCAVATIONS AT SITE N38/30, MOTUTAPU ISLAND, NEW ZEALAND

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Abstract. Site N38/30 was excavated in the 1967-8 season as a second sampling of the undefended sites on Motutapu. Results paralleled and augmented those from site N38/37. The excavation also revealed evidence of the association of a surface house and rectangular storage pit. A number of artifacts, especially adzes, are described.

N38/30 was chosen as a small test site to investigate another ridge similar to that of the main excavation at N38/37 (Davidson, this volume). Two four-metre squares were put down in checker-board fashion on a small terrace half way up the steep slope that dropped from the higher level of the ridge to the swamp below (Fig. 1). A lower terrace, about 20 feet (6.1 m) above the swamp, was rejected because a deep narrow trench parallel with the edge of the terrace appeared to be an Army slit trench.

FIG. 1. View of site N38/30 from the beach at Station Bay.

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Site N38/30 was the second terrace above the swamp. It had been made by cutting back and levelling the slope so that a crescent-shaped flat area of about 12 square metres was formed. The presence of pits on the terrace was suspected from surface indications. The scarp rose steeply as a bank on the uphill side and dropped away as a steep slope on the other three sides.

Square 1, the first 4 m square, was on the west side of the central base line and included the lower portion of the back scarp. Square 2 was forward and to the east of square 1 and the base line. Its southern boundary included the tip of, but did not go down over, the lower slope (Fig. 2). The two squares were excavated simultaneously but square 2 was divided into two sections. The first part was begun as a 2 m x 4 m area in case time did not permit total excavation. This square was later excavated fully, except for a 2 m x 50 cm central baulk on the south side, which was left intact.

DESCRIPTION OF LAYERS AND THEIR FEATURES
(Figs. 2 and 3)

The natural stratigraphy was the same as that at site N38/37 (Davidson, this volume).

Layer 1. Square 1

This consisted of the clay natural which had been modified by the construction of a floor structure, probably a house structure, lying in a north-south direction, 1.8 m x 2.8 m (Figs. 2 and 4). The external shallow drain showed clearly down the east baulk line and, along the top, by the base of the bank at right angles to the base line. It eased into a shallower line for a short way and then became a more definite, but still shallow, depression turning externally round a posthole at the 2 m line. The drain continued about one-third down the west side, gradually merging to ground level. Inside the north-east corner was a right-angled, drainlike depression, narrower (5 cm) and deeper than the outer drain. It extended for 65 cm down the east line and 40 cm along the north side. It was in this area that adzes AR 731, AR 739 and AR 738 were found. They were under a lumpy clay pan and resting on the clay floor between the two drains.

Within the outer drain of the structure were four postholes, all of which were stepped. Posthole 1 was a semi-circular hole 43 cm deep and 32 cm across. It had a step 28 cm deep on the outer side and, external to that, a small stake hole 31 cm deep. This posthole was in line with posthole 2, situated approximately in the middle of the structure. It was smaller (40 cm deep and 8 cm wide with a step 32 cm deep and 12 cm wide) than posthole 1. Posthole 3, in the south-west corner, was 50 cm across with a step about 47 cm deep. On the inner and west side of this posthole was a small drain, cut sharply in the floor, that sloped into the posthole. Outside this, the clay from the drain was piled up to form a small bank, thus making a shallow drain between the cutting and the bank. Posthole 4 was in line with posthole 3 in the north-west corner of the drain outline. The deep part of the hole was towards the base line side of the structure and was 65 cm deep. It was a slab-shaped fissure with a shallow step, about 15 cm deep, opening into it. Exterior to

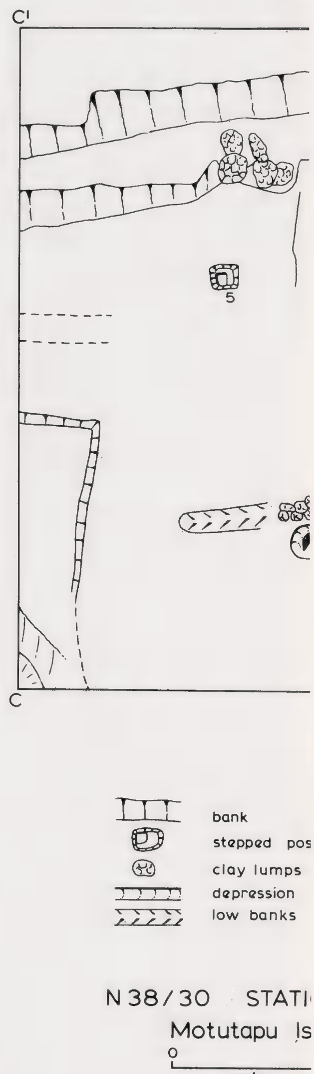
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FIG.

M 1

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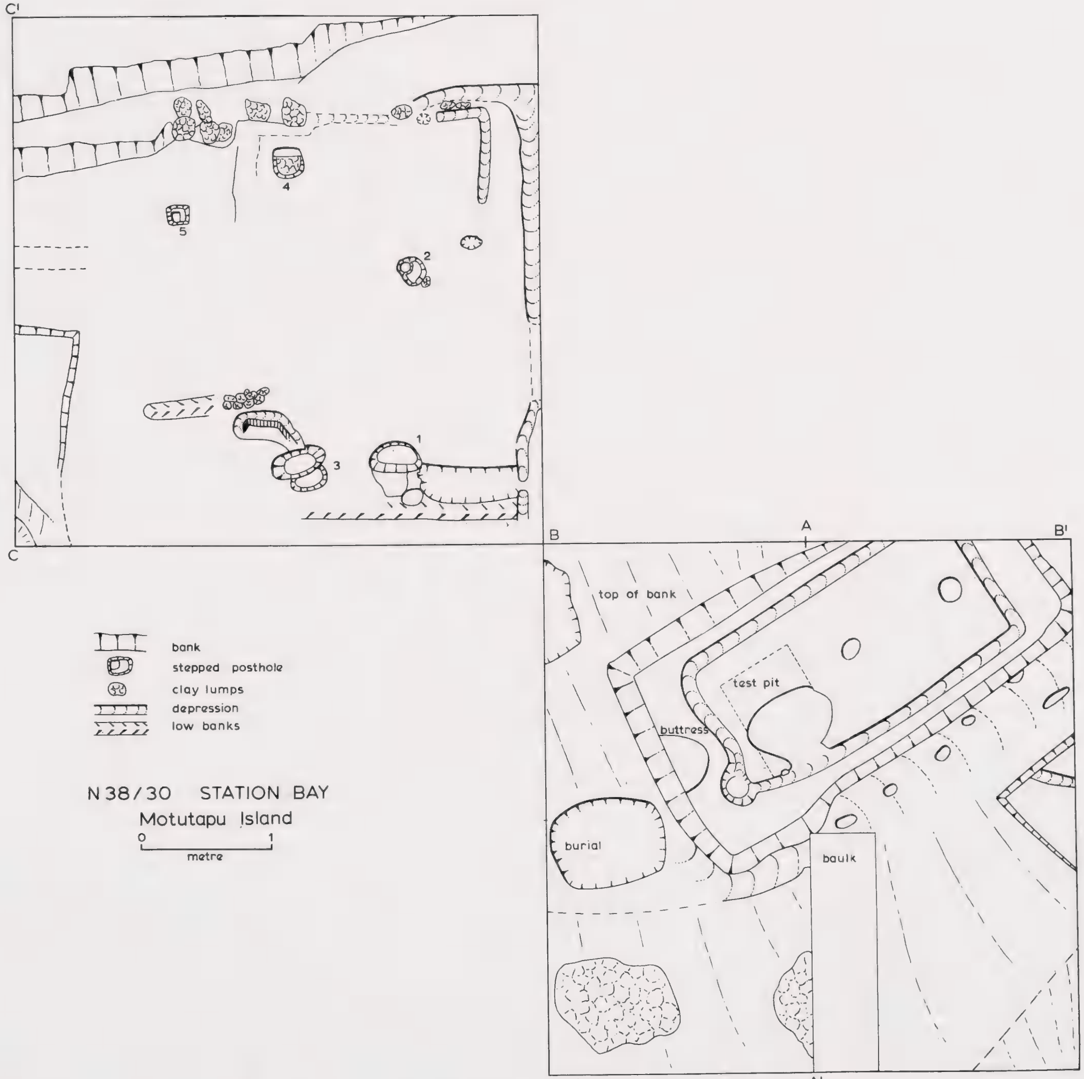
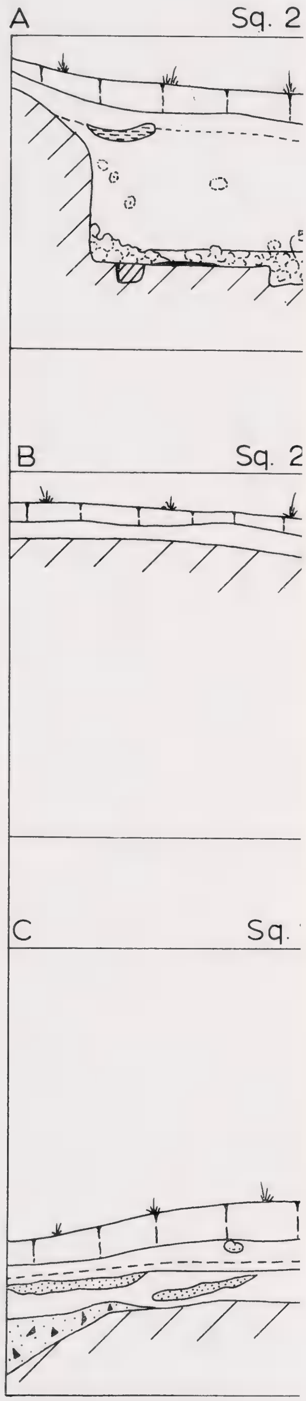


FIG. 2. Plan of features, N38/30. True north is 21° east of baseline C — C[1].

M 1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Sq. 2
B
Sq. 2
C
Sq.

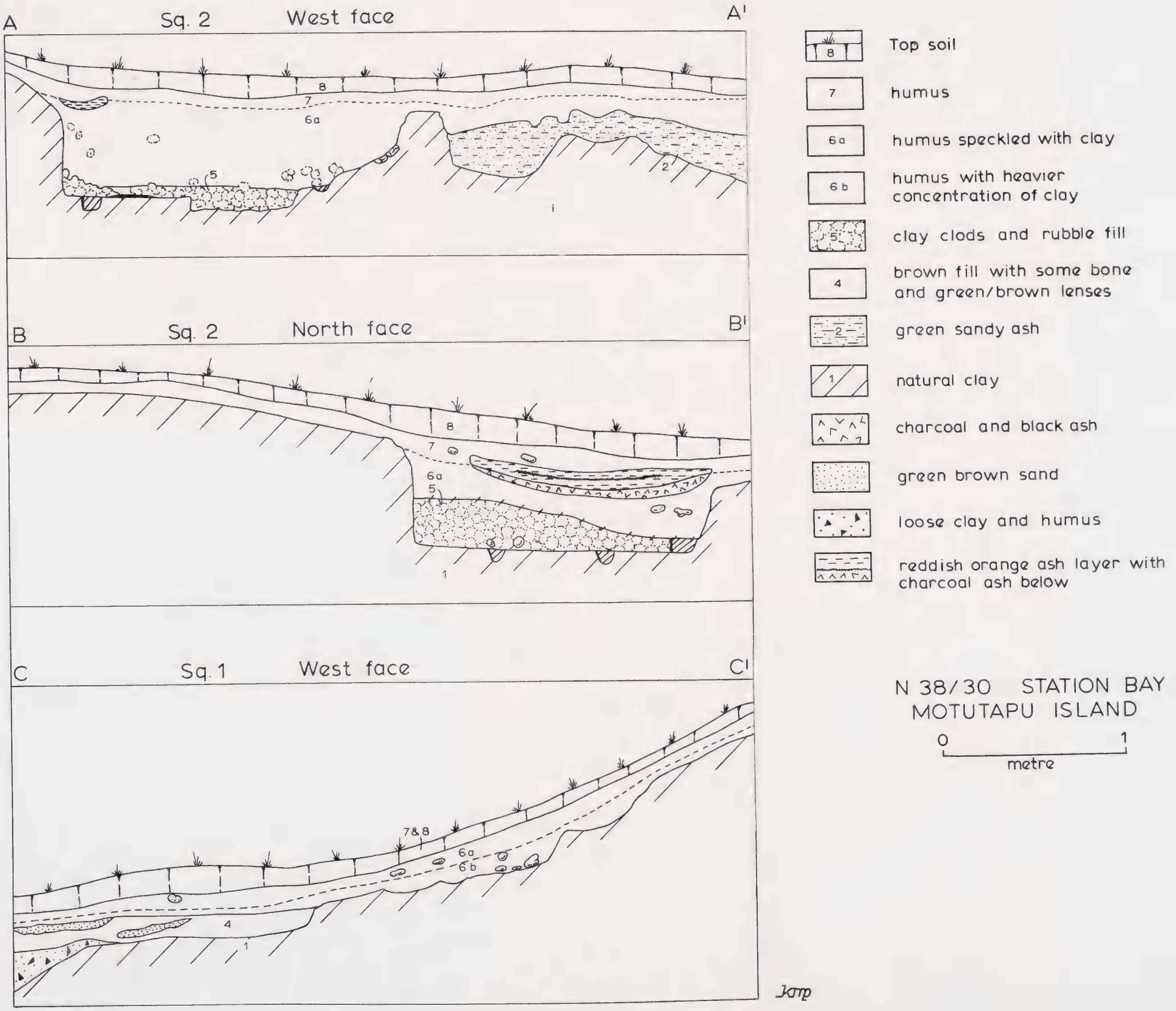


FIG. 3. Principal cross-sections, N38/30.

the structure, and about 25 cm down from posthole 4, was posthole 5 (the west drainlike depression becomes indistinguishable at about this position), which was a square, stepped hole, 16 cm wide. In the lower left corner it dropped to 51 cm, and was 8 cm across.

In the south-west part of the square the corner of a shallow rectangular pit showed. It was 48 cm wide, 100 cm long, and 10 cm deep. The floor dipped away perceptibly and disappeared into the south-west corner of the bank. This dip seemed to form the outline of the natural bank. The pit or terrace was filled with a mixture of greenish-brown sandy earth containing a little bone material of a very fragile nature and a few broken shells (*Amphidesma australe*). This layer was sealed in by layer 6.

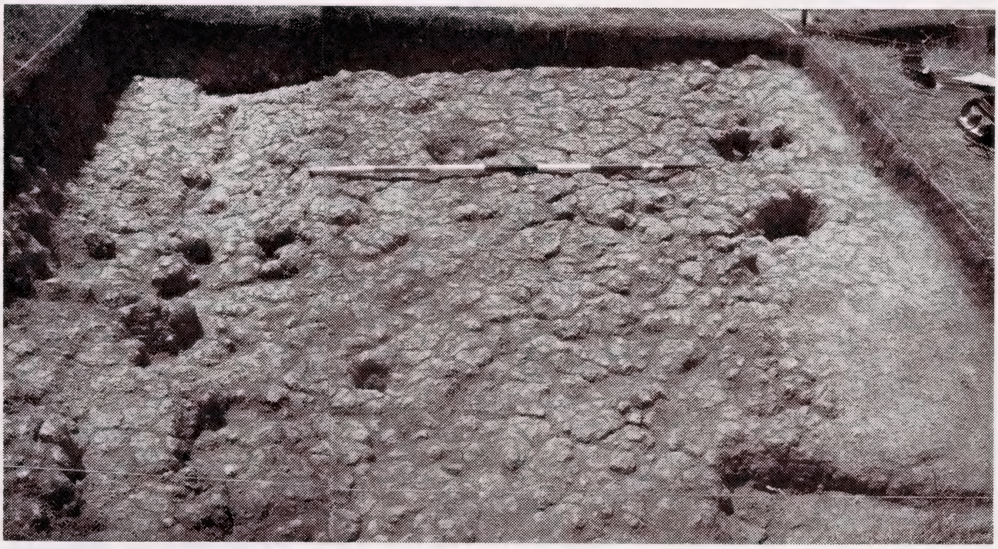


FIG. 4. House floor cut into layer 1, square 1, from the south-west, N38/30.

Along the south end of the square there was a more compressed and paler strip of clay surface material (Fig. 4). This was bounded on the north side by a low mound that terminated the house structure. This strip extended from the central ridge path to the pit/terrace structure in the south-west corner of the square.

Several alterations to the house structure appear to have occurred whereby the posts in the postholes were shored up or renewed and a new drain was cut in the north-east corner. The use of posthole 5 and its relation to the house structure, if any, are unknown. Finally, all the postholes had been plugged with lumps of clay, probably at the beginning of the layer 6 occupation.

LAYER 1. SQUARE 2

Into the clay natural in this square were cut three main features, a large storage pit, the corner of a rectangular structure similar to that in square 1, and a shallow depression. The large pit was 3.4 m x 1.7 m and was 80 cm deep at the north bank edge (Fig. 5). The floor consisted of a flat smooth area with a narrow regular drain,

8 cm wide, cut 10 cm in from the north and south sides and about 30 cm in from either end. At the west end of the pit was a low buttress. The drain curved inwards around the buttress and then out again to a deep angled sumphole in the south-west corner. The drain, where it entered the sump on the south side, had been disturbed, as had an area 60 cm x 70 cm in the pit floor near the buttress. The smooth clay floor had been dug unevenly to a depth of 8 to 10 cm. There was no sign of a posthole having penetrated anywhere below this disturbance and, as the other two postholes in the pit were 20 to 22 cm in depth, had there been a similar one near the buttress it should have shown below the disturbance. Both the drain and the sumphole were filled with a fine yellow-black water-deposited silt and fine charcoal. Over most of the smooth pit floor was a wash of ash and charcoal and a few larger pieces of charcoal as if small branches and bracken had either been burnt in the pit or had fallen into it. Layer 5 had been placed over this deposit.

FIG. 5. Square 2, showing storage pit, from the north, N38/30.

Two rounded postholes were found in the pit, one at the east central end, 22 cm deep and 16 cm across, and the other in the centre of the pit, 20 cm deep and 15 cm across. Both these holes were hollow, requiring no excavating, and were covered over by the lumpy clay fill of layer 5. Something had prevented them from being filled with rain-washed silt or dirt, and no evidence of wooden posts was found. The holes were empty except for rounded stalactite-like dust accretions that fell away from the sides when the holes were investigated.

Along the top of the south bank of the pit there were five small depressions in the weathered clay, which could have been the resting slots for beams of a roof. Below the outer edge of the bank, before the area cut away to form the corner of a

small pit or terrace, was a narrow slot, 24 cm long, possibly made by a flat board placed in the ground.

The rectangular corner of the pit or terrace contained a shallow silt-filled drain that flowed from the north-west corner into the east baulk. The silt in the drain, although containing a mixture of earth and clay, showed no charcoal or ash. The drain emerged from the north bank of the pit/terrace, but did not appear to drain the large pit above or penetrate the bank for more than 10 cm, and no trace of a drain outlet was found in the corresponding area in the large pit. The clay floor of the small pit/terrace was even, but not as smooth as that of the large pit, and sloped slightly until it entered the baulk. Apart from the drain, it was similar to the pit/terrace in square 1, layer 1. Neither of these structures was fully excavated and both remain in the baulks.

The lower third of the square consisted of a very irregular and humpy surface of weathered and crumbling clay. In the south-west corner were patches of what appeared to be charcoal. Upon investigation these were found to be the remains of tree roots. All this south-west corner was covered with the sterile undisturbed greenish-brown layer 2, believed to be Rangitoto ash. In the crumbling clay in the south-west corner a piece of kauri gum was found.

On the bank to the west of the large pit there was a shallow depression, 84 cm from west to east, 64 cm wide, and 20 cm deep, cut into the clay natural. It was in this basin that a crouch burial was found. Behind and above this the clay was pressed hard as if it had been used as a pathway. (It is still the natural pathway up the ridge.) Pressed into the surface was a white ash-like material with several lumps of orange-brown crumbly burnt clay. This coating could have been wood ash from the extensive lenses of layer 7 that seal off layer 6 in the pit.

Layer 2

This was a greenish-brown sterile sand, identified as Rangitoto ash. There was no trace of this layer in square 1 except for a few lenses in the fill of the small pit in the south-west corner. In square 2, the ash covered the lower third of the square, with the highest concentration in the south-west quadrant. In this quadrant the ash was 30 cm thick in the deepest part. Where it was undisturbed the ash rested on the weathered clay natural but, in some places in the south baulk, there were faint indications of a buried soil. The ash was shallower in the south-east quadrant of square 2, where it had been dug into in several places. It forms the basis of the soil content of layers 3 and 4. A *haangi* pit had been dug into the ash near the south baulk. At the bottom, but near the south side of the *haangi* pit, there was an irregular crumbling hole partially filled with a mesh of tiny roots supporting dusty clay. This appeared to be a natural hole, possibly left by a disintegrating tree stump. There was no ash or charcoal in the hole.

Layer 3

This was a layer of greenish-brown sandy material mixed with numerous clay flecks, a little midden, ash, and charcoal. It filled the small pit/terrace, except the drain, in square 2 and slightly overlapped its upper edge. Layer 3 also overlapped the lower portion where it merged with a thick charcoal lens that continued to the edge

of the *haangi* pit where a heap of *haangi* stones was found. The layer then appeared as a thin stratum above sterile layer 2 and covered the irregular hole in layer 2. It continued as a thin layer into the central half-baulk, but did not re-appear on the other side.

Layer 4

A greenish-brown sandy material, similar to layer 3, composed layer 4, but it was mixed with an increasing amount of midden, obsidian, flakes, and stones. The fill of the small pit in square 2 was covered by layer 4 and it extended up to the highest point of the bank on the south side of the large pit. It covered all the lower portion of the south-east quadrant until it disappeared into the central half-baulk, but did not appear in the fill of the big pit or in the north half of the square except in the fill surrounding the burial which was then sealed off by a clay layer. The fill covering the burial contained a few small stones, fragments of broken stone, and one half of a pipi shell, *Amphidesma australe,* which was in the earth found inside the skull. The fill was similar in composition to layer 4 and surrounded the whole skeleton under the clay layer that had been placed over it. The fill of the small pit in square 1 also contained material similar to layer 4 although it had slightly more clay flecks mixed with it. This fill had no shell, but there were a few fragments of crumbling fish bone with one or two fragments that may have been bird bone.

Layer 5

This consisted of a covering of clay lumps and earth over the smooth floor of the large pit in square 2. It was thinner at the east and south, but became thicker towards the west wall. Beneath this deposit at the west end, resting on the original floor, was a lump of charcoal and a wash of greasy charcoal and clay with occasional burnt bracken stalks. The clay lumps had not been packed down to make an even floor and the cracks were filled with layer 6 material. This clay at first suggested a cave-in of the north bank of the pit which was very cracked and weathered, but further investigation showed that a drain had been roughly formed out of lumps of clay pressed back from the south wall of the original pit. This drain continued round to the east wall where it became more definite and wider (14 cm) and entered the north baulk. The east end of the drain was filled with dirt and silt, but further round, on the south wall, it contained small lumps of clay as well as sediment. This clay loosely filled and covered the disturbed area in the clay natural of the original floor. It surrounded but did not cover the buttress. The sump hole was also covered. The bank of the pit did not appear to have been cut back to provide this covering, but in the north-west corner a portion had crumbled down on to the floor at a later date. It would seem more likely that the clay for this floor came from another part of the site, possibly from the unexcavated square on the terrace, behind and level with square 1. Surface features suggested some sort of pit in this area. Alternatively, it may have come from the alterations in square 1, but this is doubtful as the clay surface there, though irregular, does not seem to have been dug into very much.

Layer 6 (Layer 6A and 6B)

Where layer 6 rested directly on the clay, the prevalence of clay particles in the black earth was more pronounced. As the layer developed, fewer and fewer clay particles appeared. Because of the problem of soil movement or creep, all the artifacts

found between the clay, or layer 2, and the first 10 cm of layer 6 were treated as layer 6B and all those above, as layer 6A.

Layer 6 covered the whole site except at the point where the two squares met. Here was situated the path between the house floor and the pit. This path ran up the central part of the ridge where the clay natural was covered by a thin layer of humus and ash material, probably layer 7, and then the turf. This was only a small area, situated on the crest as the path dropped down a slight bank.

Where layer 6 rested on layer 2, Rangitoto ash, there was a slight mixing of the two soils, but the latter was of a much sandier nature and clearly distinguishable. Layer 6 there still had clay particles mixed with it, but fewer than where it rested directly on the clay.

It was in layer 6 that most of the artifacts were found. This layer formed most of the fill of the large pit and merged amongst the clay lumps on the false floor (layer 5). Layer 6 covered all of square 1 and also square 2 except at the south-east edge where the bank had been built up with a few lumps of clay. It lapped against this bank, but did not cover it and only thinly covered layer 4 in this area.

Layer 7

This was a black humus layer with no clay particles. It covered a large portion of the site, but became indistinguishable from the turf layer in many places. It was deeper at the base of the bank in square 1 where it had accumulated as a result of activity and erosion higher up the ridge. This layer was also deeper where it filled the pit depression. In this depression, and into layer 6, had been dug the two *haangi* pits filled with ash. Piled up by the side of the east *haangi* was a collection of ten smooth unbroken greywacke stones. Stones, broken and unbroken, were a feature of layer 7, the largest proportion being found at the base of the bank in square 1 where they probably rested after rolling down from higher up the ridge. Other stones could have been associated with the layer 7 *haangi.* Only one flake was found in this layer.

Layers 7 and 8 have been combined in Fig. 3 because it was difficult to differentiate between them and they were probably part of the same build-up process.

The Burial

Soon after the removal of the top soil, layer 7, and a portion of layer 6, the skull of a skeleton was uncovered (Fig. 6). This was crushed at an earlier period, apparently by natural causes (the head was situated close to the ridge path), but further crushing occurred during excavation. The shattered skull case was filled with a greenish-brown material that contained half a pipi shell. The skull was lying on its right side and was contained within a U-shaped basin formed by clay lumps moulded into a hollow and a certain amount of excavation of the clay natural. The upper portion of the skull was facing out towards the open end of the hollow. The clay moulding went over the neck of the skeleton and slightly over the top of the shoulders as if to protect or outline the head because of the shallowness of the grave.

For cultural reasons, this image has been removed.
Please contact Auckland Museum for more information.

FIG. 6. Burial, square 2, N38/30.

The teeth were worn almost down to the jaw and were very yellow and discoloured. The skeleton appeared to be that of a mature woman.

Further excavation revealed a hard clay pan, 5 to 10 cm thick, that had been plastered over the rest of the skeleton. It was difficult to remove without damaging the bones beneath, but finally the whole burial was exposed. The body was lying on the right side in a crouch position with the left arm folded across the top of the chest and the left hand placed under the head as if the face had been cupped in the hands. The legs were bent up, but were outside the arms. The skeleton was in an articulated position except for the toe bones. Two of the toe bones were found about 15 cm east of the end of the burial in layer 6, and one large toe bone was found in the layer 6 fill of the large pit under the fire pit in the west end. This probably came from the skeleton as no other human bone was found on the site. The rest of the toe bones were not found.

The skull, rest of the skeleton, and the clay pan were surrounded with a greenish-brown sandy material, Rangitoto ash, with some earth, small stones, broken stone, and natural flakes in it. There was a piece of kauri gum in the fill at the south end of the depression near the jaw. The greenish-brown sandy material was very similar in appearance to layer 4, but without any midden except the pipi shell. This places the burial in association and contemporary with layer 4. If the burial had occurred during the accumulation of layer 6, it should have been surrounded by a layer 6 type of fill, but this did not occur under the clay pan. The disturbance in the clay floor of the large pit may have been caused by the removal of clay with which the body was covered and the head outlined.

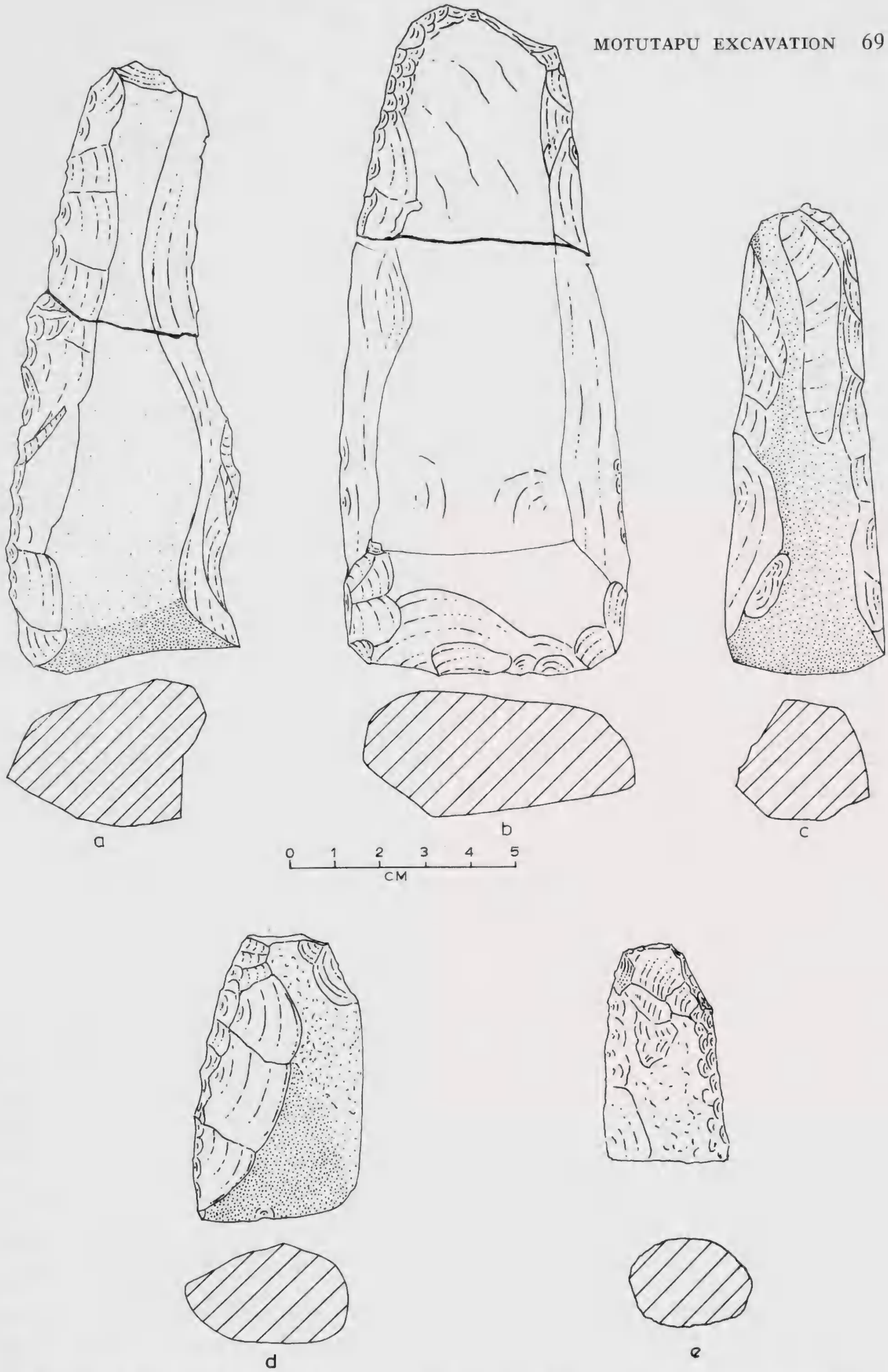


FIG. 7. Adzes from layer 6, N38/30: a. AR 779 and AR 862, from square 2, layer 6B. b. AR 842 and AR 771, from square 2, layer 6A. c. AR 752 from square 1, layer 6A. d. AR 724 from square 1, layer 6A. e. AR 732 from square 1, layer 6B.

ARTIFACTS

Adzes

Most of the adzes did not fit into any current classification. They fell into two main categories:

(a) small, 9.6 cm and under, with lenticular or plano-convex cross-sections and tapered towards the butt, and

(b) medium sized, between 9.7 and 14.9 cm.

Two of the latter were complete, but broken in half. AR 752 (Fig. 7c) was nearest in size to the smaller group, but differed from them in its subtriangular section. Only two adzes appeared to be complete, AR 752 (Fig. 7c) and AR 724 (Fig. 7d). AR 752 was a dark fine-grained stone, probably greywacke, but finer than that usually found on Motutapu. It was sub-triangular apex down in cross-section, and was shaped entirely by flaking. All the edges left by the flaking had been ground and the blade sharpened front and back. AR 724 was a short (6.2 cm) partly polished adze with a deeply flaked butt. Several flakes had been struck from the left back side after polishing and the side edge rechipped as if to modify it. A third adze, AR 738 (Fig. 8b), although without a polished blade, had a partially smoothed front blade end surrounded by hammer dressing suggesting use wear rather than grinding.

Square 1, layer 1. Four lenticular adzes were found resting on layer 1. Three roughouts in a cache, AR 737, 738, and 739 (a blade end), were on the clay between the later internal and the earlier external drain of the house site. These adzes were covered with clay lumps that could have come from the excavation of the later inner drain. Their similarity in size and appearance suggests that they were made by the same person (Fig. 8). A roughout, AR 740, was found in a depression in the clay near posthole 3 and is also associated with layer 1.

Square 1, layer 6B. AR 744 was a large flake from the upper side, showing secondary flaking and some hammer dressing. AR 732 was the butt end of a chisel type with an ovoid/round cross section. It was hammer dressed all round (Fig. 7e). AR 741 was a small piece of the butt end of a roughout, partially hammer dressed on the upper surface.

Square 1, layer 6A. AR 752 was the sub-triangular adze already mentioned (Fig. 8c). AR 724 was described above (Fig. 8d). AR 764 was a butt end of a roughout, but hammer dressed on the front, flaked and partially hammer dressed on the back. It is very similar to the adzes found in layer 1. AR 760 was a small butt end of a narrow adze, or possibly a chisel, flaked on the back and hammer dressed on the front side. AR 753 was the butt end of a larger roughout, somewhat sub-triangular in cross-section. It was bruised rather than hammer dressed along one side.

Square 2, layer 6B. AR 779/862 (Fig. 7a) were two halves of a crudely flaked, medium-sized roughout. The blade end, AR 779, was found resting almost on the undisturbed layer 2, below and to the right of the burial. The butt, more triangular in cross-section than the blade, was found about half way down in the fill of the pit

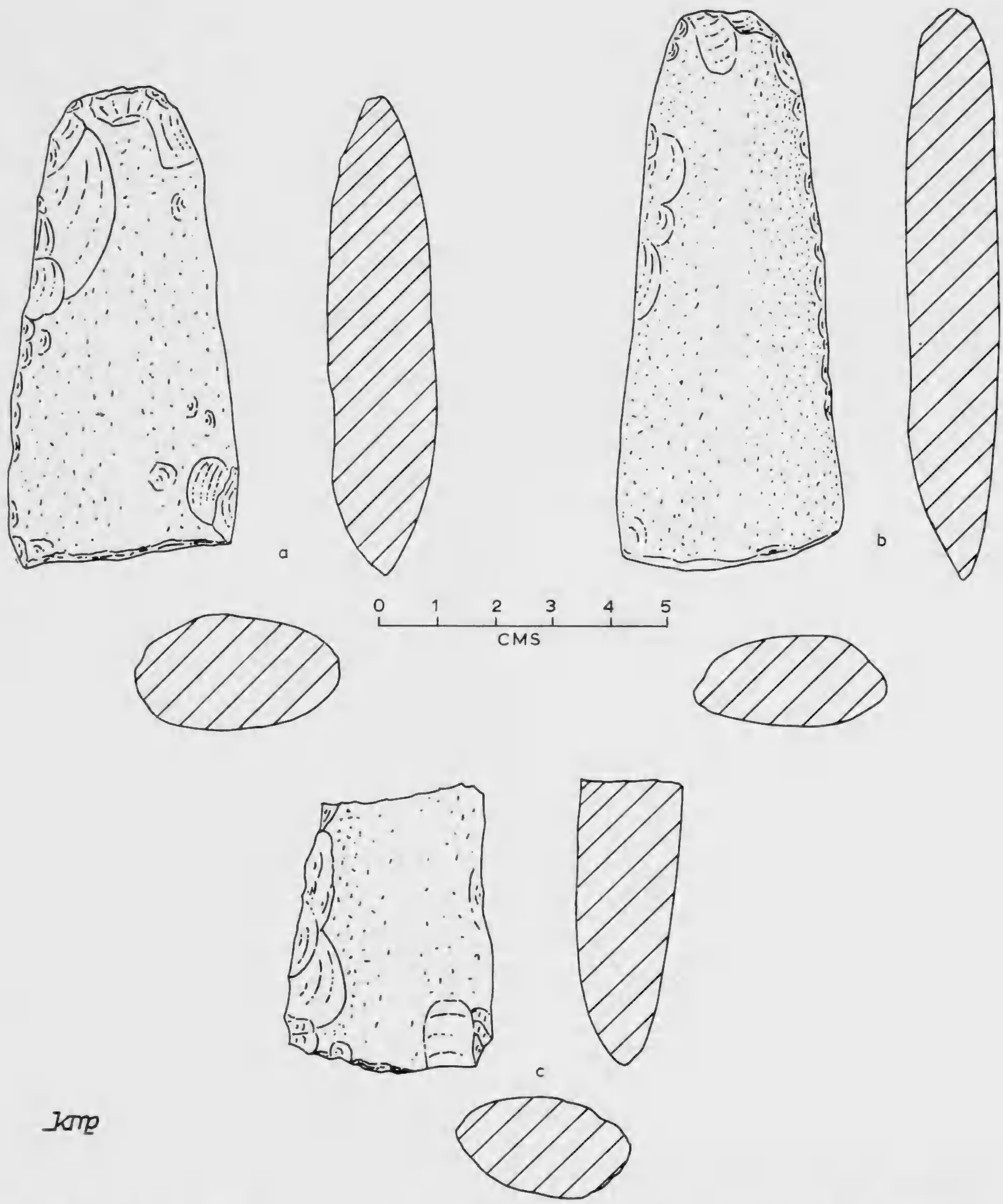


FIG. 8. Cache of three incomplete adzes found resting on layer 1 in square 1, N38/30: a. AR 737. b. AR 738. c. AR 739.

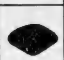
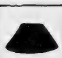
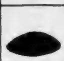
in layer 6A. This suggests some back fill into the pit as a toe bone, presumed to be from the skeleton, was found in the same area. AR 805, formed from a large flake, was pointed and flattened front and back, and bruised along one edge. It appeared to be the butt of a roughout.

Square 2, layer 6A. AR 771/842 (Fig. 7b) were two halves of a medium-sized roughout, quadrangular in cross-section and slightly curved on the front surface.

The back had two large flakes struck longitudinally, and a very small part of the ridge between the two flakes showed hammer dressing. The rest of the roughout was flaked. The front surface still had some cortex showing. Both parts were found in the pit fill about 20 cm apart. AR 801 was a small complete roughout, hammer dressed on the front surface and flaked on the back. The blade was shaped by flaking back from the front edge. The "cutting edge" surface was a flat plane about 5 mm thick but, with a little more work, could have been sharpened for use. This adze was very similar to those found in layer 1. AR 830 was the butt end of a lenticular roughout, hammer dressed front and back, with a large flake out of the back surface. It was similar to those in layer 1. AR 847 was a small butt end of a lenticular roughout, hammer dressed on the front surface. Some cortex showed. It

TABLE 1A

ANALYSIS OF ADZES IN SQUARE 1, N38/30

Sq.1 no.	LAYER	LENGTH CM	WIDTH CM	THICK. CM	CROSS SECT.	WEIGHT OZ.	STONE	HAMM DRESS.	FLAKED	POL. BLADE	COR-TEX	COM-PLETE	INCOM-PLETE	ROUGH-OUT
737	1	8	4	2		3	g.w.	x	x			x		
738	1	9·6	3·6	1·5		$3\frac{1}{2}$	g.w.	x		parti-ally?	x	x		
739	1	4.9	3·6	1·8		2	g.w.	x	x				blade end	
740	1	7·2	3·2	1.4		$1\frac{1}{2}$	g.w.	x	x				butt end	
741	6b	4.8	3·8	2.6		2	g.w.	x	x				butt end	
732	6b	4·5	2.1	2		$1\frac{1}{2}$	g.w.	x	x				butt end	
744	6b	8·7	3·6	1·4		2	g.w.	x	x			x		x
752	6a	10·3	3.5	2.3		4	g.w.		x	x		x		
724	6a	6.2	3.7	1.9		$2\frac{1}{2}$	g.w.	x	x	x		x		
764	6a	5·2	3·7	2.1		2	g.w.	x	x				butt end	
753	6a	6.6	4	2.8		4	g.w	x	x		x		butt end	
760	6a	4.1	3.1	2		1	g.w.	x	x		x		butt end	

was flaked on the back surface, and appeared similar to the layer 1 group. AR 861 was the butt end of an oval stone showing considerable cortex. It had several large flakes struck from it.

All the adzes on the site were made of greywacke, probably of local origin, except for AR 752. This could have been made from a sea-rolled beach stone, or have been brought from another locality where a fine-grained greywacke occurred.

Twelve of the twenty adzes, part adzes, and roughouts were lenticular or plano-convex in cross-section (Tables 1a and 1b). One adze was sub-triangular in cross-section; one roughout was sub-triangular in mid cross-section though more quadrangular at the blade end; one small flake roughout appeared to be sub-triangular in its unfinished state; one roughout was quadrangular; the final four were indeterminate.

The medium adzes were shaped by flaking, but the small adzes had also been heavily hammer dressed with the minimum of flaking. This was probably because of the technical difficulties of flaking a small object. The twelve hammer dressed adzes or roughouts were surprisingly homogeneous in appearance and suggested either one craftsman or a tradition of adze-making for a specific purpose. The majority of adzes were found in square 1.

TABLE 1B

ANALYSIS OF ADZES IN SQUARE 2, N38/30

Sq. 2 no.	LAYER	LENGTH CM	WIDTH CM	THICK. CM	CROSS SECT.	WEIGHT OZ.	STONE	HAMM. DRESS	FLAKED	POL. BLADE	COR-TEX	COM-PLETE	IN-COM-PLETE	ROUGH OUT
779	6b.	13.8	4.8	2.8		$7\frac{1}{2}$	g.w.		x		x	bro-ken in 2		x
862	6a.													
805	6b	6	4	1.4		$1\frac{1}{2}$	g.w	x	x				butt end	x
801	6a	6.6	4	1.8		2	g.w.	x	x		x	x		
830	6a.	6.2	3.9	1.8		2	g.w.	x			x		butt end	
847	6a	4.6	3.3	3		1	g.w	x	x		x		butt end	
771	6a	14.9	6.3	2.7		12	g.w		x		x	bro-ken in 2		x
842														
861	6a	6.3	3.3	1.8		1	g.w.	x	x					x
854	6a	6.4	5.8	2.8		3	g.w.	x	x		x		butt end	x

Three pieces of burnt clay were found in square 2, layer 4. These showed the hollow impression of a broad flattish surface. One of these concave surfaces fits snugly over the surface of a lenticular adze, AR 731, and might possibly have stuck to the blade of a similar adze used when digging out clay, to be subsequently removed and then accidently baked in a fire. This could suggest that the small adzes were used to dig out at least part of a clay structure, although clay stuck to a digging stick, if it had a flattish blade, would leave a similar impression.

Several of the small adzes were so near to completion that they could have been used as tools with little further finishing, that is, they were a collection of potential tools. Many of the adzes showed areas of weathered rock cortex suggesting that they were made from local stone quarried from nearby and that the cracking, weathered external blocks formed a large part of the base material used.

Stone Flakes

There were 868 stone flakes on the site. The majority were greywacke, but 25 from layer 6 were of a greenish chert that fractured irregularly. All of the external surfaces of this greenish stone showed water-worn areas. Only one small flake suggested any use. It had a sharp end, and the edge of one side had been ground down to make a finger hold. Many of the greywacke flakes showed weathered cortex (26%) or a water-worn surface (13%). Probably unworked blocks of stone or pebbles were taken to the site rather than roughouts. One point six per cent (1.6%) of the flakes had either a polished edge or secondary flaking. Fifteen per cent (15%) of the flakes showed some hammer dressing. Possibly many of the roughouts were worked to the hammer dressing stage on the site and then modified again before finishing, leaving a large number of hammer dressed flakes.

One of the possible sources of the greywacke stone is an outcrop between Administration Bay and Pig Bay, about a mile (1.6 km) from Station Bay across the Island. A small eroded reef runs from the hill out into the sea. Owing to weathering, this outcrop consists of squarish blocks that break naturally into suitable sized lumps or else are sufficiently fractured to be broken off. The reason that a factory site such as the Tahanga quarry at Opito has not been found on Motutapu could be that the blocks of stone were taken elsewhere, such as Station Bay, to work into tools. However, no blocks of stone were found in the excavation. A large

TABLE 2

ANALYSIS OF STONE FLAKES, N38/30

LAYER	FLAKES									
	Total		Worked edge		Hammer dressing		Cortex weathered		Water-worn surface	
3	2									
4	10								4	
5	1									
6B	249	855	5	14	42	129	59	232	37	112
6A	606		9		87		173		75	
Total in site	868		14		129		232		116	

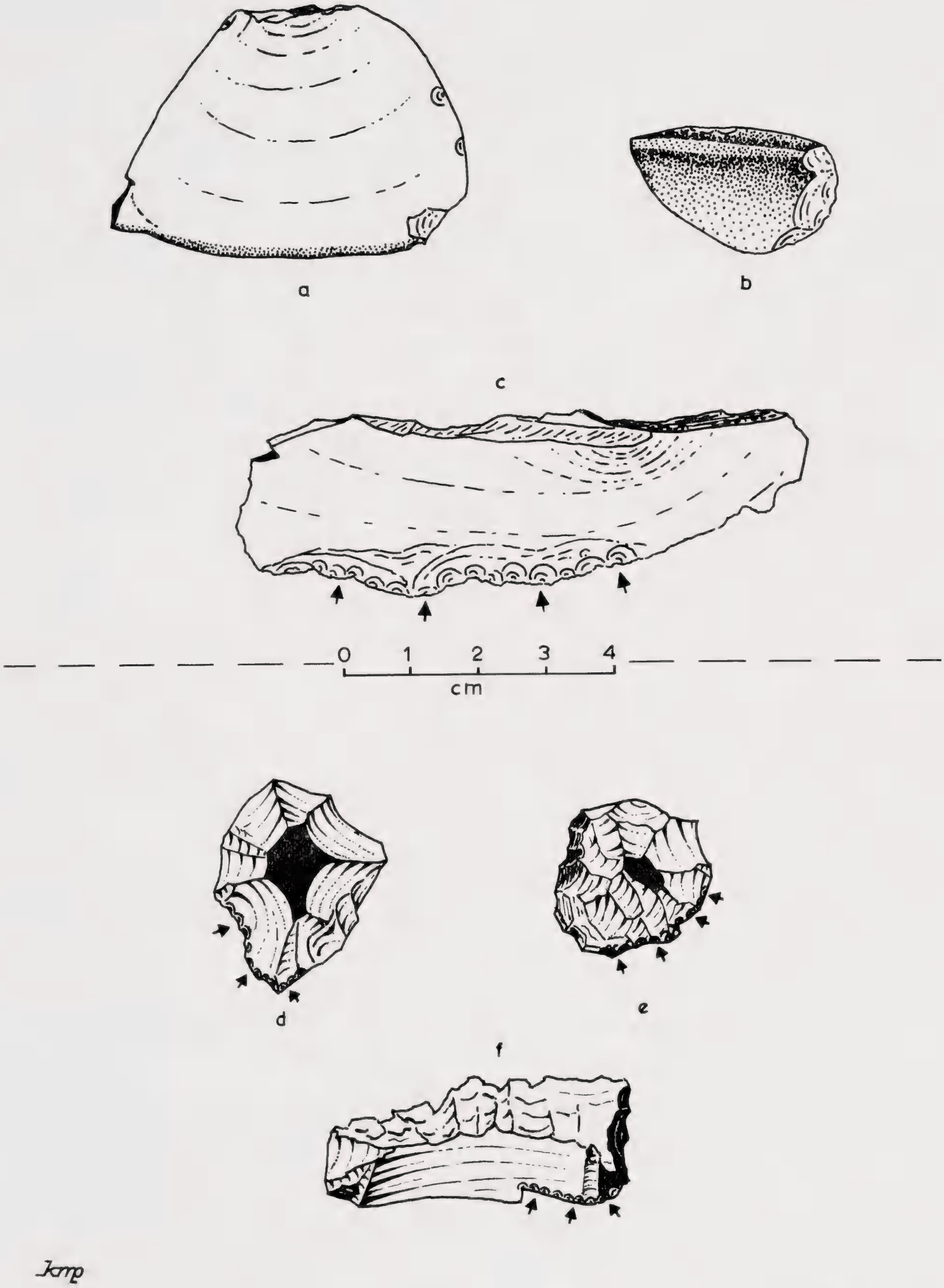


FIG. 9. Flake tools, N38/30: a - c, greywacke. d - f, obsidian. a. AR 728b. b. AR 728a. c. AR 728c. d. AR 761. e. AR 782a. f. AR 782b.

greywacke stone core, with flakes struck off it, was found at the base of the ridge below the site. It was an isolated find, but could have been the type of block used for adze or tool making.

The majority of flakes were found in layer 6A and B, and this layer represents a period when stone working took place on the site. The presence of adzes and roughouts in layer 6 confirms this.

Two flakes from polished adzes were found. One was a small chip, showing a polished surface with an angle of hammer dressing along one side. The other, AR 728a (Fig. 9b), was a part blade end and corner of a polished adze. The end away from the blade showed a smoothed or ground-down edge, so that the cutting portion of the blade could have been further used as a flake tool. One flattish flake, AR 728b (Fig. 9a), had been sharpened along the end and one side, forming a knife or scraper. AR 728c was a long narrow flake with secondary flaking, forming a saw or serrated edge. All these flakes were from above the house floor in square 1 in layer 6.

Fourteen flakes (1.6%) in the site showed sharpened, secondary or pressure-flaked edges, suggesting use. One large flake, 9 cm long, 6.1 cm wide, and 1.9 cm thick, came from layer 7. It could have been a roughout for a small adze. It was the only flake found in layer 7 and is not included in Table 2.

The stone flake assemblage was worked on a "contour diagram" (Fig. 10) suggested by Shawcross (1964, p. 13). It showed that about 50% of flakes were

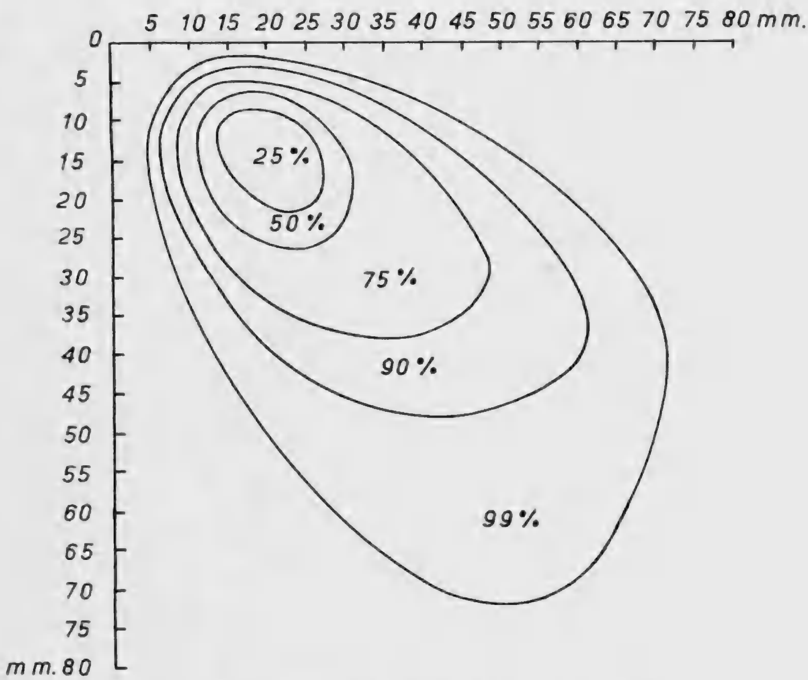


FIG. 10. Dimensions of greywacke flakes, N38/30.

much the same size and had the same length/breadth ratio. They fell within the 25 mm square. The medium flake contour (about 40%) tended to be skewed to width more than length. The few large flakes (under 10%) were longer than they were wide. Overall, the flakes were squarish, with a few reaching well beyond the

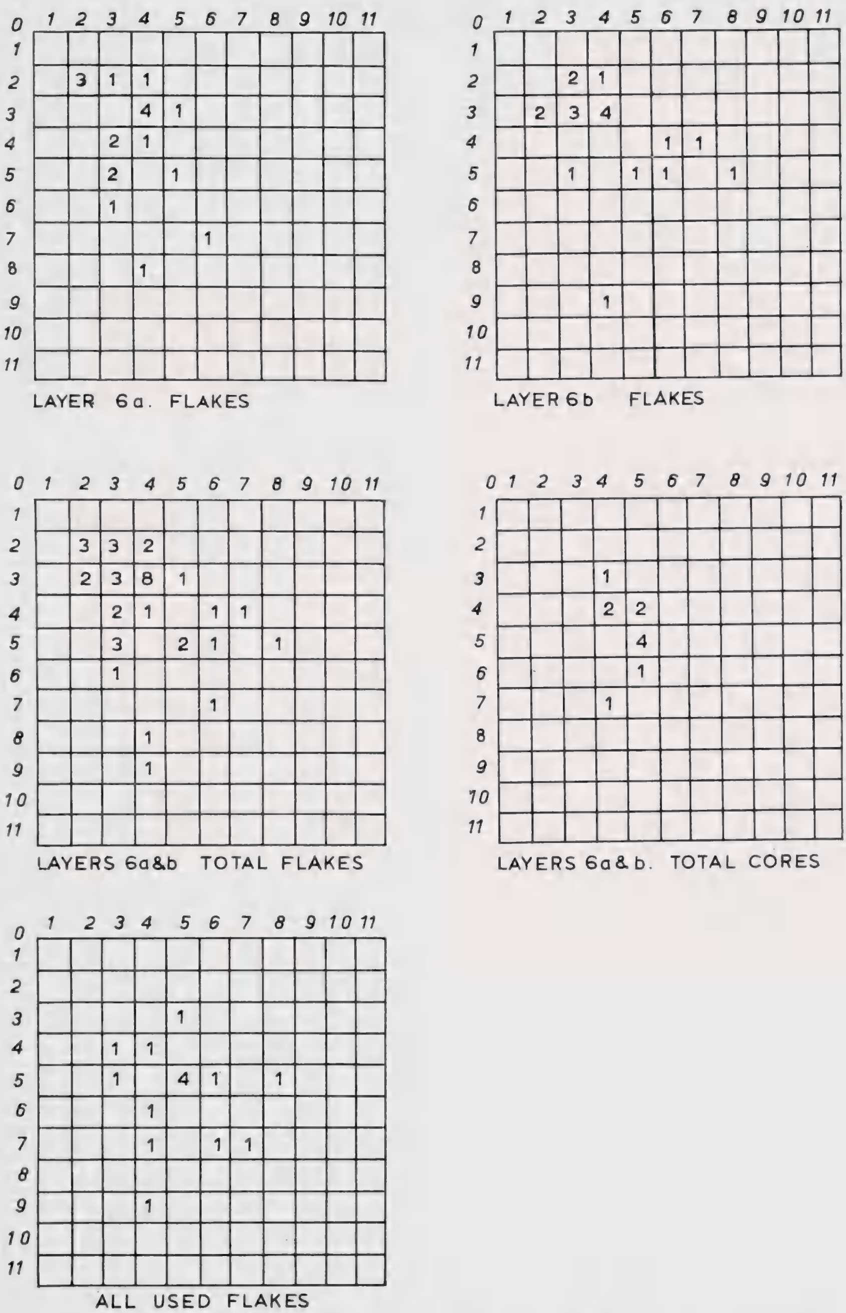


FIG. 11. Dimensions of obsidian, N38/30. Measurements in 5 mm squares.

average length or width. Most seemed to be by-products of stone working and not struck to make specific tools, although a few had a polished or worked edge suggesting use as a knife or scraper (Fig. 9). These flakes did not appear to be any different from the others and were probably chosen from waste material and then modified for use.

Considering the number of flakes and the smallness of many of the adzes present, it is probable that the final products of the stone working were taken from the site for use elsewhere, either as roughouts or as completed adzes.

Obsidian

The number of pieces of obsidian found in the excavation was 78. Of these, 18 were sent for dating and source identification, 4 were set aside as of uncertain context, and 56 were used for analysis.

The flakes in layer 6 tended to be more wide than long, although the difference was slight. When layer 6A and B were measured separately, however, 6B had more wide flakes and 6A had more long flakes. This difference did not occur in the stone flakes. The used obsidian flakes were almost even in their length/breadth distribution (Fig. 11).

TABLE 3

ANALYSIS OF OBSIDIAN, N38/30

LAYER		FLAKES					
	Total	Core type	Flakes showing use	Unused flakes	Colour Grey	Colour Green	Irregular external surface
4	7	—	2	5	7	—	1
6B	24	5	4	15	19	5	1
6A	25	6	9	10	22	3	2

Although 26 pieces showed signs of use or secondary flaking, the obsidian appeared to be incidental in the site rather than suggesting activity requiring a sharp cutting tool or scrapers. Two pieces were knife-like, and one had a partly indented edge as if something had been squared off at a right angle (Fig. 9f). Two core-like pieces were shaped to a drill point by secondary flaking (Fig. 9d), and showed use on both sides of the point. Three other core-like pieces could have been deliberately made tools or have had small flakes struck off them until they were of no further use. The ends of these "cores" were very crushed and showed pressure flaking, suggesting that they might have been used as semi-circular scoring tools (Fig. 9e). Pressure on these would produce a rounded groove in wood.

Hammer Stones

Eight complete hammer stones were found and one broken portion. Two were found in layer 4, two in layer 6B, and four in layer 6A. Six of the hammer stones appeared to be red jasper, one was a yellow-green chert, and one was greywacke. All appeared to be water worn stones. The broken lump showed crushing along the remaining edge. Two small flakes of jasper were also found, one in the pit fill, layer 6A, and the other in layer 6B below the pit.

AR 858 and 836, from layer 4 in square 2, were two small angular stones of red jasper that showed crushing around the side angles. One of these was tested on a broken greywacke boulder and it produced fine hammer dressing, similar to that found on the small adzes in the site, with very little effort and pressure. AR 731 was a quadrangular yellow-green chert stone, crushed and chipped at either end. It was found in square 1, layer 6B. AR 780 was a small red jasper stone, similar to AR 858 and 836. It was found in square 2, layer 6B. AR 726 was a roundish flattened stone, flattened top and bottom. The circular sides showed extensive crushing and, in three places, large flakes or pieces had been knocked off. The circular sides and the sharp edges left by flaking showed signs of use. AR 824 was a squarish jasper hammer stone crushed around its angular edges. AR 823 was a round, part grey, part red jasper hammer stone. One surface had been flaked either to obtain a new face or to round it for easier handling. The rest of the stone was crushed on all surfaces, suggesting more or longer use than the other hammer stones. It was found in square 2, layer 6A, just below layer 7. AR 870 was the only greywacke hammer stone found in the site. It was a round, smooth, water-worn stone, flattened top and bottom, with several flakes knocked from one flattened surface. It showed crushing

TABLE 4

HAMMERSTONES, N38/30

SQUARE	LAYER	NUMBER	STONE	SIZE			WEIGHT
				Length	Width	Thickness	
		AR		cm	cm	cm	g
2	4	858	red jasper	5.3	3.3	2.6	72
2	4	836	,, ,,	4.6	4.3	3.1	85
1	6B	731	chert	8.0	5.2	3.2	85
2	6B	780	red jasper	4.5	3.9	3.4	184
2	6A	726	,, ,,	7.2	6.8	4.6	284
2	6A	824	,, ,,	6.5	4.8	4.0	170
2	6A	823	grey and red jasper	6.2	6.2	4.6	227
2	6A	870	greywacke	6.0	6.0	2.8	142

all round the sides. It was found near AR 823 in square 2, layer 6A, just below layer 7. One large, green, water-worn stone was found in layer 6B, almost resting on the Rangitoto ash, below the skeleton. It was flattened top and bottom. There were a few flakes scattered nearby, but none that appeared to be in direct association with it. It did not show bruising typical of hammer stones. Its purpose is unknown, but it could have been suitable as an anvil.

Greenstone

One tiny chip of greenstone was found in an earth-filled crack (layer 6B) in the clay near posthole 3, square 1. It was a broken part of the bored hole of an ornament and showed polished facets around the edge of the hole.

Bone

Apart from the skeleton, only small pieces of unidentified crumbling bird or mammal bone were found in the occupation layers. Occasionally, well-preserved fish

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rib bones were found, mainly in layer 4. In layer 6A, square 1, the jaw of an animal larger than a rat was found. This appeared to be part of a small rabbit; there was a disturbance in the ground just below the turf and this animal is found on the island.

Two dog canines were found in square 1. One was in layer 6B, in the earth filling a crack in the clay, very close to where the greenstone chip was found. It had been fashioned into a two-piece fishhook barb. The original surface had been ground down to about half the thickness of an average canine, but the curve remained. Just below the sharpened top the nerve canal was exposed. About 5 mm below this was a v-shaped fine groove, forming a double barb. Beyond this barb the tooth had been cut in, thus elevating the small double barb. About 3 mm beyond this the side of the tooth had broken away, exposing the root chamber. The other canine was found in the same square, in layer 6A. It was well preserved, with an almost polished look, but showed no working.

Stone

Both fractured stone, apparently derived from cooking activities, and water-worn pebbles were found in quantity. Weights of both kinds are given in Table 5. It is evident from the Table that most stone occurred in layer 6A.

TABLE 5

WEIGHT OF UNWORKED STONE, N83/30

SQUARE	LAYER	FRACTURED STONE	WATER-WORN STONE
		Kilos	Kilos
2	3	6.5	4
2	4	6.5	1.5
2	6B	4.5	1.5
1	6A	72	16
2	6A	46	15
1	7	6.5	.5
2	7	6.5	1.5

INTERPRETATION

Square 1 contained the floor of a house structure. Postholes 1 and 2 were in alignment longitudinally, and were situated in the posterior and anterior part of the structure. The remains of a drain round part of the west side, along the north side, and continuing down the east side, outlined the house. At the anterior end the ground was raised slightly as a low mound. This formed a raised lip to the house and could have supported a barge board or *paepae*.

The storage pit in square 2 opened on to the central ridge path, just opposite to where the path outside the house joined it. The pit had two postholes in the posterior third and central portion of the floor, but no posthole in the anterior portion. This would facilitate entry down into the pit, and movement in the confined space.

The cooking area was placed below the storage pit, and good use was made of the Rangitoto ash for *haangi* construction.

The death and careful burial probably ended the first occupation. A depression was scraped out of the hard clay by the ridge path below the pit. Moist clay from the pit floor was dug out to form a shallow built-up extension to the grave and contain the body. Some soft earth from the nearby midden area was placed around the body and, finally, it was covered with clay.

Probably the same group of people began the second occupation shortly after the first ended. The posts of the house structure were shored up as shown by the "stepping" of postholes 1 and 2 and the smaller depressions associated with them. Postholes 3 and 4 were added, and a new drain cut in the north-east corner. An attempt was made to form a false floor over the storage pit, apparently to make it usable again with the minimum of effort. Probably the posts were still in position in the pit, and were removed prior to the building of the new floor. Lumps of clay were merely placed over the holes, leaving the deep part empty, possibly with a view to re-opening them when the new floor had consolidated. This work was not completed and once again the site was abandoned.

During the third occupation, the site was used as a working rather than a habitation area. Possibly a new habitation and storage area was built higher up the ridge (the whole ridge has a series of terraces on it), and the site was used as a floor for working stone. The postholes in square 1 were plugged with clay to level the floor, and the gradual building up of layer 6 began.

The time between the second and third occupation does not seem to have been long, as layer 6B, representing the beginning of the third occupation, was heavily impregnated with clay particles that originated, most probably, in the weathered clay surfaces of the house structure and pit, and layer 6 material filled the cracks in the clay of square 1. There was also the similarity of the adze types, from the earliest occupation to those of layer 6, and the use of red jasper as the preferred hammer stone in layers 3, 4, and 6.

Later, the terrace ceased to be used as a working area. Two fire pits were dug into the surface of layer 6 in the pit depression. Debris, earth and stones from activities up the ridge, formed layer 7 and, finally, the site became covered with turf.

CONCLUSIONS

The site gives evidence for three occupations by a domestic unit that changed its constituent members and its living and working conditions through time. The site also gives evidence that the house floor, storage pit, and *haangi* and midden area, comprised a domestic unit such as that postulated by Groube (1965). Although he said that it was not known what sort of storage went with the surface house, this site provides clear evidence of a storage pit associated with a house structure.

ACKNOWLEDGEMENTS

I would like to thank all those who took part in this excavation.

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ANALYSIS OF MIDDEN FROM TWO SITES ON MOTUTAPU ISLAND, NEW ZEALAND

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Abstract. Midden material from sites N38/37 and N38/30 consisted of shells and fishbones. At site N38/37 pipi shells, *Amphidesma australe,* were most common, while at N38/30 tuatua, *A. subtriangulatum,* were more important. This difference is probably due to separation in time. The main fish was snapper, *Chrysophrys auratus,* with head bones represented more frequently in the midden than body bones.

This paper describes midden material from sites N38/37 and N38/30 on neighbouring hills at Station Bay, on the east coast of Motutapu Island. The sites were excavated in the Christmas holidays of 1967 (Davidson, Leahy, this volume). Both N38/37 and N38/30 are terraced pit sites about 200 yards (182 m) back from Station Bay beach.

The midden contained mostly shells and fishbones, and gave evidence of exploitation of an area which covered at least a mile (1.6 km) to the north and three miles (4.8 km) to the south-west. In this area there are five types of marine environment, differing in range and number of available food species.

1. The first is the Station Bay beach. This consists of large smooth pebbles, and is a poor source of food because the smooth surfaces of the stones and the constant movement from wave action discourage the growth of large edible molluscs.
2. The nearest sources of sea foods are the rocky headlands at either end of the beach. Present day shellfish found on the headlands are all typical rocky shore species: periwinkles, *Lunella smaragda;* limpets, *Cellana* sp.; small gastropods such as *Zediloma* and *Cominella,* and larger rock gastropods such as *Neothais scalaris* and *Haustrum haustorium.* The rock oyster, *Crassostrea glomerata,* is rare, although found extensively on rocky outcrops further south. Mussels, *Perna canaliculus,* are small and sparse: this may be the result of an earlier period of over-exploitation, as conditions on the headland seem favourable to mussel growth.

   This pattern of stony beaches and rocky headlands extends some distance north and south of Station Bay.
3. A third type of environment is the sheltered, rather muddy, soft beaches on the eastern and south-eastern coast of Motutapu, from which can be obtained cockles and pipi. The shallow muddy estuary between Rangitoto and Motutapu Islands, three miles (4.8 km) from Station Bay, is a particularly rich source of these molluscs.
4. On the more exposed sandy beaches on the north coast of Motutapu tuatua are found.

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5. The fifth type of marine environment open to economic exploitation from Station Bay is the offshore fishing ground. Station Bay is situated on a good fishing ground: the offshore sea bottom is a muddy platform, which eventually grades into the hard shelly substratum which lies in all the main channels of the Waitemata Harbour (Powell 1937). This muddy platform is rich in marine life, and nearly a third of the diet of the snapper is made up of species found here.

Station Bay, then, is situated in a locality which is favourable for the exploitation of fish, especially snapper.

Method of Analysis

The midden material from site N38/30 represents the total material recovered in the course of the excavation; that from site N38/37 represents all the material except a little of the midden from square M-11 which was excavated toward the end of the dig when time was short. The distribution of midden in the excavations at site N38/37 is shown in Fig. 1.

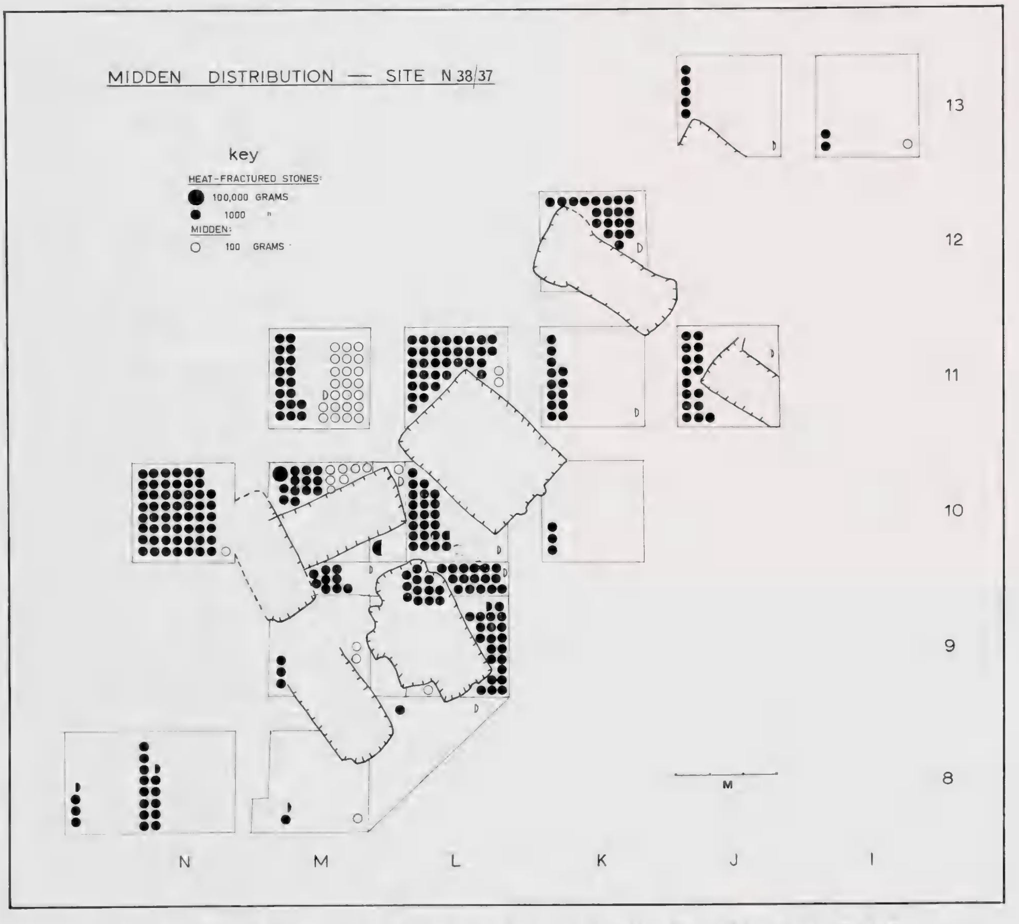

Fig. 1. Distribution of midden, site N38/37, Station Bay, Motutapu Island.

Shells were weighed, identified, counted and, in the case of cockles, graded according to size (greatest diameter). Bivalves were counted only when they had a hinge, and gastropods when the spire was intact.

Processing of fishbones followed roughly the procedure described by Shawcross (1967, pp. 111-4). They were sorted according to bone type and, where possible, were identified by means of a comparative collection of all the common North Island edible fish. All the fish of the comparative collection had been weighed and measured (total length, standard length, head length, snout length) before being reduced and, by a calculation based on a comparison of the right dentaries (the most common bone in the midden material), the approximate size and weight of the snapper present in the midden were obtained.

Length was calculated according to simple proportion. The formula is:

lx = dentary length (midden material),
Lx = unknown length of fish (midden material),
ls = dentary length (comparative collection),
Ls = known length of fish (comparative collection).
$Lx = (lx \,.\, Ls)/(ls)$. Length given is total length.

In calculating the weight of fish from midden material, it has been assumed (Shawcross 1967, p. 114) that a change in the linear dimension of a fish results in a volumetric change (and hence weight change) proportional to the cube of the linear change. Cassie (1957, p. 387) found, however, that the weight of snapper is proportional to the 2.69th power of the length. Thus the weight of snapper in the midden has been calculated as follows (suffixes as above):

$$(Lx)^{2.69}/(Ls)^{2.69} = (Wx)/(Ws)$$
$$\therefore \quad Wx = (Ws \,.\, lx^{2.69})/(ls^{2.69})$$
$$\therefore \quad Wx = Ws(lx/ls)^{2.69}$$

The minimum number of snapper in the midden of site N38/37 is 20. Using the formula above, their total (gutted) weight is calculated to be 768 oz (21.8 kg). The minimum number of snapper in the midden of N38/30 is 11 and their total weight is 278 oz (7.9 kg). The average size of snapper in the midden of N38/37 was much larger than the average size of those in N38/30, i.e., 38 : 25 oz (1.1 : 0.7 kg). As with the difference in species distribution, this could possibly be explained as being due to different fishing techniques.

Bones tend to dissolve more quickly in an acid soil, especially if the soil is well drained. In an attempt to evaluate the preservative qualities of the soil at sites N38/37 and N38/30, pH tests were made of the three layers in three test pits. Test pit 1 was dug on the edge of site N38/37, near square K-12 (Fig. 1); test pit 2 was on a nearby unexcavated terrace on the same hill; and test pit 3 was on the flat swampy strip between the hill and the beach.

The natural clay of the three test pits was slightly alkaline, with pH readings between 5.6 and 6.7. The pH readings of layers 1 and 2, test pits 2 and 3, were similar, with an average pH of 6.2. Layer 2 from test pit 1, however, was much

more alkaline (pH 4.3), and the top soil was slightly more alkaline (pH 5.8). This is probably the result of the midden shell, present quite extensively in layer 2 of test pit 1. If the layers were alkaline or close to neutral in the past, as they seem to be today, they would have been favourable to bone preservation.

Results

Figure 1 shows the distribution of stone and shell in site N38/37. The stones were predominantly cooking stones and, as might be expected, were concentrated in those areas of the site where there were evidences of *haangi.*

One of the main problems of the archaeologist who attempts to reconstruct prehistoric activity from midden remains is to separate economic activity based on cultural preferences from that governed by environmental factors. The former transcends the immediate environmental situation, and is therefore useful in dating or describing a culture; the latter is particular to a certain site, is in a sense accidental, and is consequently of less archaeological value. Figure 2 shows that there was a decided preference for soft shore, rather than rocky shore mollusca at sites N38/37 and N38/30, but it is not clear whether such preference reflected cultural values or simply environmental exigencies.

Two types of rocky shore edible shellfish which cluster in colonies, and are relatively easy to obtain in large numbers, are mussels and rock oysters. They are available, though not extensively, on the present-day rocky shore at Station Bay, and are present in large numbers on the rocky beaches further south. If there was a preference for rocky shore mollusca (which could be met as they are available on nearby beaches), it is difficult to understand the absence of mussels and rock oysters from the midden material. Exploitation of the two species, as reflected in the midden was minimal (less than 10 examples of either species).

The mussels found in the midden were very small (under 5 cm long). Mussels growing on the rocky shore of Station Bay at the present time are of small size, which may indicate that conditions there do not favour the growth of many or large specimens. It is possible, however, that the small size and scarcity of mussels at Station Bay today, and in the midden from sites N38/37 and N38/30, are the result of past periods of local over-exploitation.

Figure 2 also shows that the greater part, in both number and weight, of the shell midden material from both sites is made up of soft shore bivalves. At site N38/37, pipi, *Amphidesma australe,* are the most common shellfish, and tuatua, *A. subtriangulatum,* are very rare. On site N38/30, tuatua are the most important mollusc and there is a corresponding lack of pipi. Cockles, *Chione stutchburyi,* are common on both sites. Most are of small size (one third of the cockles from site N38/37 are under 2 cm diameter), which implies indiscriminate gathering.

The nearest beach with tuatua is about three-quarters of a mile (1.2 km) from Station Bay; the most prolific source of cockles and pipi, the Motutapu-Rangitoto channel, is three miles (4.8 km) distant. At both sites N38/37 and N38/30, preference for soft shore mollusca was decided enough to outweigh the disadvantage of distance.

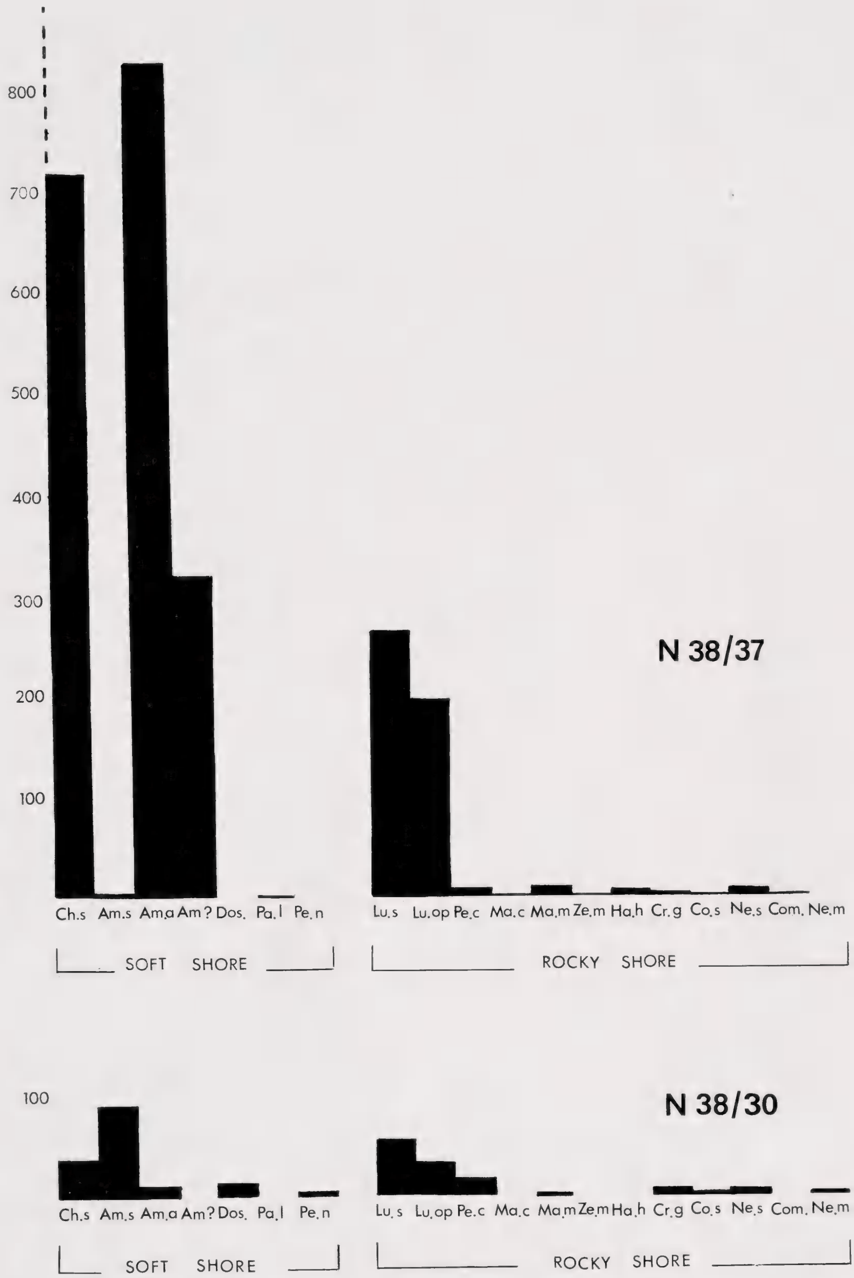

FIG. 2. Shell material in midden at sites N38/37 and N38/30, Station Bay. Horizontal axis—species of shells: Ch.s *Chione stutchburyi;* Am.s *Amphidesma subtriangulatum;* Am.a *Amphidesma australe;* Am? *Amphidesma* (broken); Dos. *Dosinia* sp.; Pa.l *Paphirus largillierti;* Pe.n *Pecten novaezelandiae;* Lu.s *Lunella smaragda;* Lu.op opercula of *Lunella smaragda;* Pe.c *Perna canaliculus;* Ma.c *Maoricrypta costata;* Ma.m *Maoricrypta monoxyla;* Ze.m *Zediloma morio;* Ha.h *Haustrum haustorium;* Cr.g *Crassostrea glomerata;* Co.s *Cookia sulcata;* Ne.s *Neothais scalaris;* Com. *Cominella*?; Ne.m *Nerita melanotragus.*
Vertical axis—number of shells.

The inhabitants of site N38/37 seem to have favoured pipi as a staple shellfish food, while those of site N38/30 consumed tuatua. Such choice seems to be cultural preference rather than environmental necessity. Since the sites are close, and both are undefended, it is reasonable to assume that, if both were occupied contemporaneously, the inhabitants would share some bond of cultural identification, if not kinship identification, and would follow closely similar patterns of economic exploitation. Differences between the two sites are probably due, therefore, to separation in time rather than to cultural differences in two contemporaneous groups.

There was evidence in the midden of both sites that the pre-European inhabitants had exploited the excellent off-shore fishing grounds. The relative proportion (by weight) of fishbone to shell was 1 : 6, a ratio which gives no absolute measurement of the importance of fish as opposed to mollusc foods, but will give a comparative indication of the value of fish foods when similar proportional measurements are available from other sites.

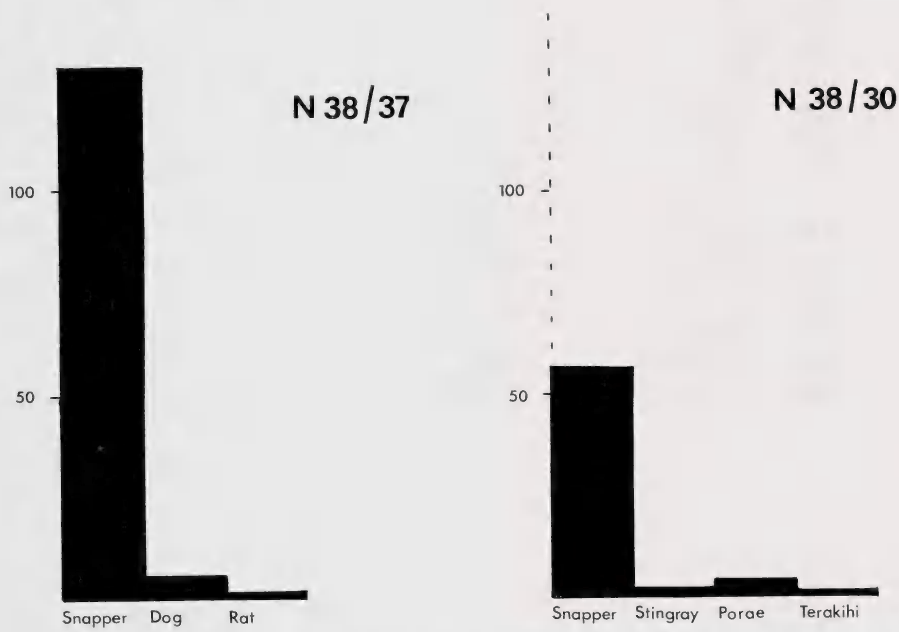

FIG. 3. Bone material in midden at sites N38/37 and N38/30. Horizontal axis—kind of bone; vertical axis—weight in grams.

Figure 3 shows that the main fish in the bone material is snapper; sting ray, porae and terakihi are also present, but probably only a single example of each. Dog and rat were also found, but near the surface and not associated with midden. They may represent post-occupation deposition.

The preponderance of snapper is probably due to the fact that the sites are near good snapper fishing grounds; also the bones of snapper are less fragile than those of such common fish as flounder and terakihi.

By means of the formula shown earlier, the approximate sizes and weights of snapper in the midden were calculated. Snapper from site N38/37 show a fairly even size/weight distribution. Out of 11 specimens present in the midden of site N38/30, however, it is estimated that 6 were under 11 inches (28 cm) long and weighed less than 7 ounces (198 g) (Fig. 4). Since Maori line fishing was designed for the catching of medium to large fish, it is possible that these small snapper were caught by the indiscriminate process of netting. The absence of fish-hooks from the two sites, and the wide range of species found in the midden of site N38/30, seem to reinforce this suggestion. Obviously, fish caught by nets would exhibit a wider range of species as well as size, than those caught by fish-hooks.

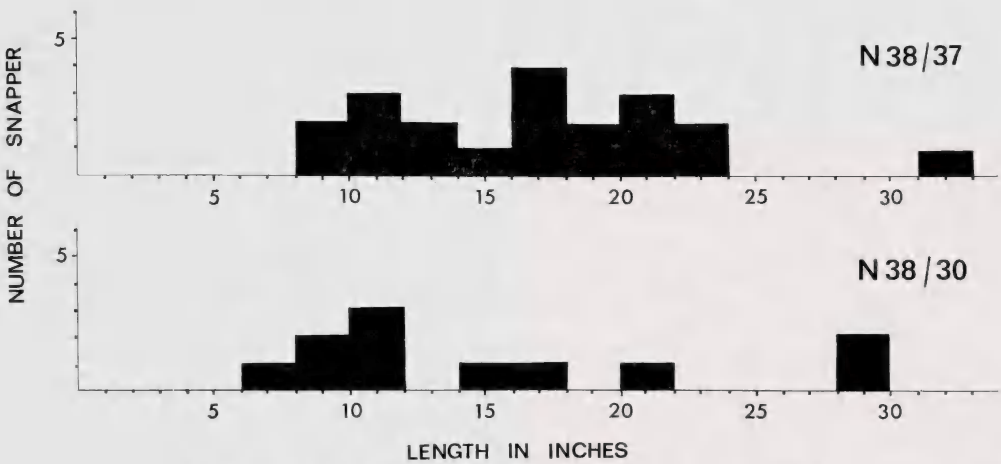

FIG. 4. Length of snapper in midden, sites N38/37 and N38/30.

It is possible that rays and other cartilaginous fish were more common as food than the evidence of a single sting ray spine would indicate. It is probable that the stings of rays were removed immediately they were caught (and therefore would not be present on the site), and certainly the cartilage of these fish could be expected to disintegrate quickly. At the present day, rays are quite common on the muddy platform off Station Bay, and sharks are often found there, particularly in summer.

Figure 5 shows that at Station Bay (as at Galatea Bay, Ponui Island—see Shawcross 1967, p. 113), there was a higher proportion of snapper head bones in the midden than body bones. This implies at least that the dismembering of snapper did not follow the European pattern of cutting off and throwing away the heads. Indeed, there is ethnographic evidence that fish heads were considered delicacies (Turei 1911, p. 25). In interpreting the differential occurrence of head and body bones at Galatea Bay, Shawcross (ibid. pp. 113-4) suggested four explanations:

that the jaws are the strongest bones and survive better . . .

that the excavators tend to select the head bones . . .

that dogs had scavenged the fish scraps . . .

that some degree of selection had been carried out on the site when the fish were being prepared:

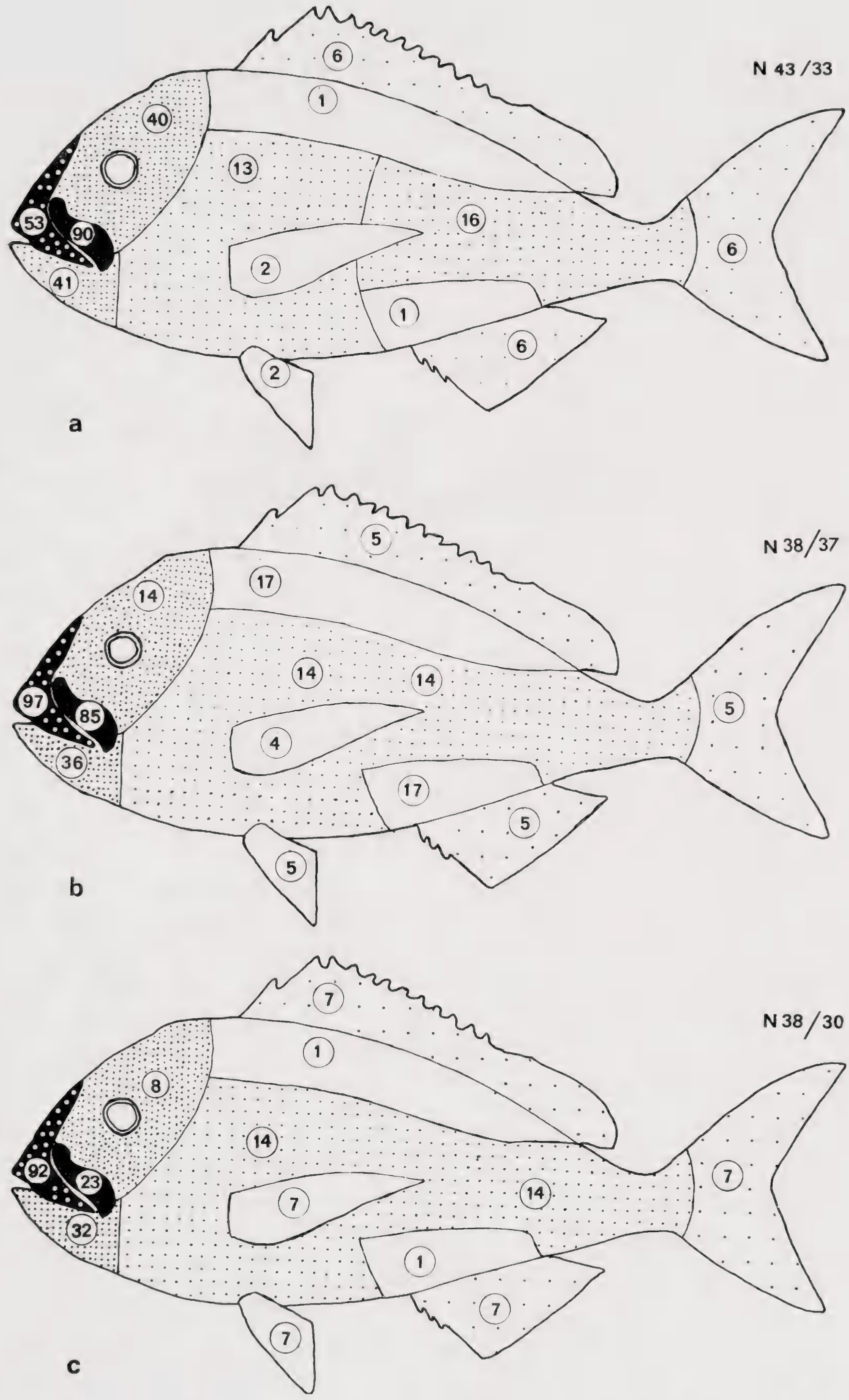

FIG. 5. Relative percentages of snapper bones in midden. a. Site N43/33, Galatea Bay, Ponui Island. Reproduced by courtesy of F. W. Shawcross. b. Site N38/37, Station Bay, Motutapu Island. c. Site N38/30, Station Bay, Motutapu Island.

> "The heads may have been separated from the trunks on the site, where all of them, but only some of the trunks, were eaten, leaving perhaps three-quarters of the trunks to be preserved by drying and subsequently taken elsewhere for consumption at another season."

The simplest explanation is that the relative scarcity of body bones is due to differential survival. Although the pH tests indicated a non-acid soil favourable to bone preservation, the dissolution of the bones over time would only be slowed and not halted completely. Most of the vertebrae consisted only of a centrum. The apophyses had been detached and either had dissolved or were not collected. This dissolution of the vertebral apophyses would be matched by the disappearance of at least some of the interneural and epipleural spines which are similar in size and construction. Similarly, there are dorsal spines in the midden—the fins had not been detached before bringing the fish to the sites, but no dorsal rays which would have been among the first parts to dissolve.

The second obvious factor is the greater ease of collection of head bones in excavation as they are generally larger and more easily recognisable than body bones. No sieves were used, and the collection of small bones in these circumstances was subject to the selectivity, conscious or unconscious, of the excavators.

There is no archaeological evidence that the occupants of sites N38/37 and N38/30 traded the fish bodies or took them elsewhere to consume. The flaking floor at site N38/30, and the extensive structural remains at site N38/37, imply that they were not specialised fishing camps. It is likely that fish caught by the occupants were eaten at the sites, not elsewhere. The predominance of head bones over body bones of snapper can be explained adequately by the factors of differential survival, and selection by the excavator, and is probably a common feature of coastal middens.

Conclusions

The midden of sites N38/37 and N38/30 was not extensive enough to produce other than tentative conclusions. It has indicated some patterns of economic activity. Sea foods rather than land-dwelling birds were used as a source of protein; there was a preference for soft shore rather than rocky shore mollusca, pronounced enough to outweigh the disadvantage of distance. There seems to have been a tendency to exploit snapper rather than other harbour fish, but this was probably due to their abundance rather than to any preference. Differences in the shellfish consumed suggest that the two sites were occupied at different times, a possible relationship that was not indicated by the structural and artifactual evidence.

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A MAORI PIT SITE, N42/114, IN PARNELL, NEW ZEALAND

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Abstract. A rescue excavation on a site, N42/114, at Parnell is described. No cultural material other than two pits and some amorphous postholes was encountered. The original state of the pits and their function are discussed, and they are considered to be for kumara storage. The economic function of the site is discussed with regard to environment, settlement pattern and seasonal movements. The site is considered to be late because of its specialised nature.

At the end of Alberon Street, Parnell, is a small reserve, owned by the Auckland City Council, and known as Alberon Park. It consists of a sharp ridge between two intermittent streams (Fig. 1). The land was acquired by the Council in 1948 and, after one attempt to subdivide it for building sites, it was cleared of rough vegetation in 1964, grassed and planted with trees. Part of the site had been bulldozed at this stage. In 1968, the City Council decided to remove the ridge. Two vague impressions on it suggesting rectangular pits, two flat areas, and a possible terrace scarp, indicated a prehistoric site. The pits were confirmed in the spring by a vigorous growth of grass. The Parks Department of the City Council was approached for permission to conduct a rescue excavation under the auspices of the Auckland War Memorial Museum, and this was organised and directed by Miss J. M. Davidson on three weekends in October 1968. The author helped with the direction and made the necessary records for this report. The interpretations and conclusions made here are the author's. Labour was supplied by members of the Auckland University Archaeological Society.

Figure 2 shows the position of the site in relation to the sea, other known prehistoric sites, and the underlying geology which determines both the best defensive situations and the agricultural potential of the derived soils. The scoria cones are the conspicuous defensive sites in the area, but one peninsula site on a breached tuff ring, and some cliff edge sites where Waitemata series sandstones and siltstone adjoin the coast, also occur. Agriculturally, the weathered tuff is the most fertile soil, although the alluvium can be fertile where well drained. Soils on the Waitemata series material are adequate, but those on the scoria cones are undeveloped and unsuitable as are some of those on the lava flows.

Site N42/114 is situated almost halfway between a fertile tuff ring with an associated cone and pa, and the sea at the former St. Georges Bay. The alluvial soils in St. Georges Bay were used for market gardens early in the European settlement of Auckland, making it likely that they were also suitable for prehistoric agriculture. The earliest descriptions of the Auckland Isthmus describe it as covered with bracken (e.g., Dumont d'Urville 1950, p. 154), the rhizome of which was an important Maori food. It would seem that the area was favourable for the Maori, and this particular site was well placed.

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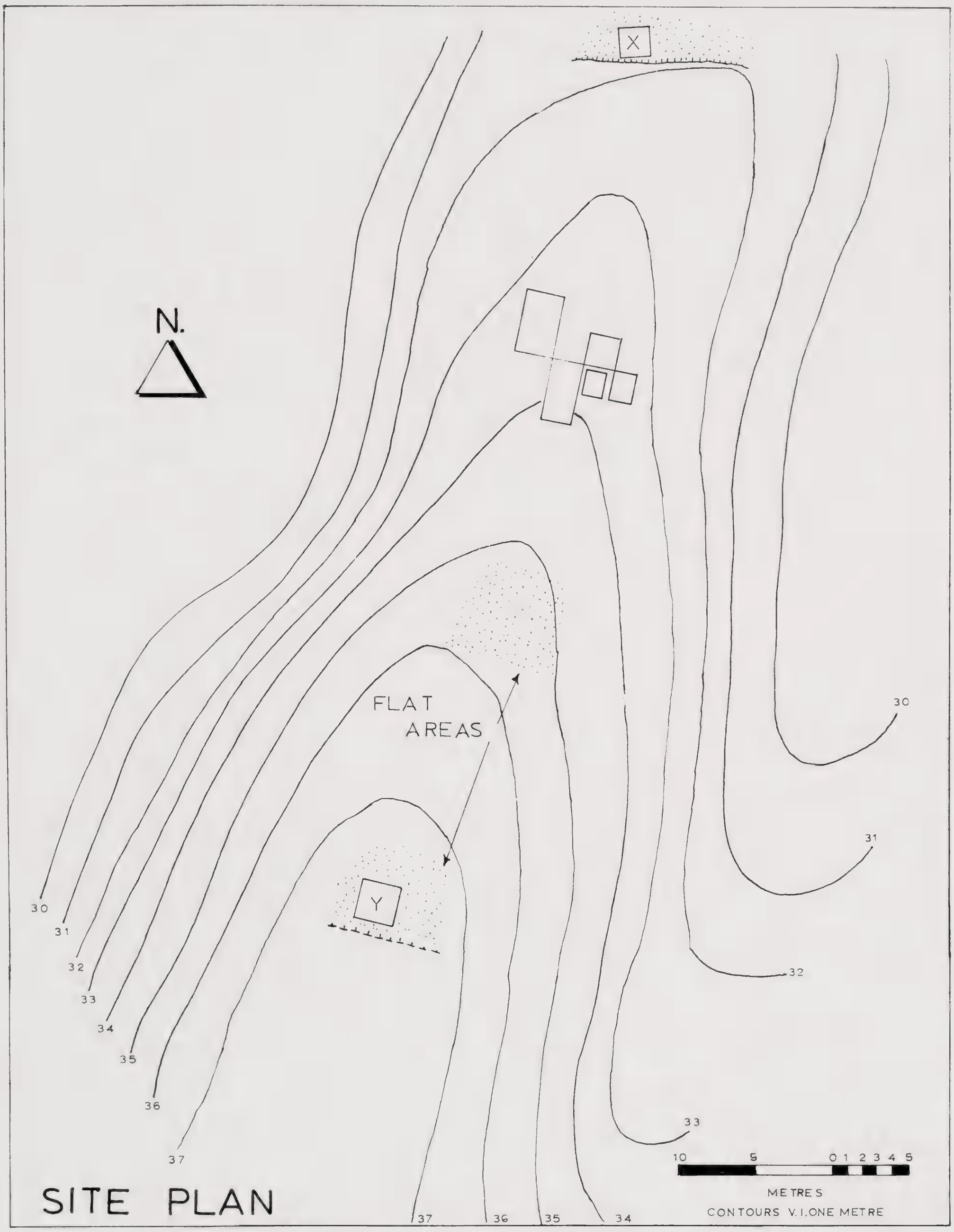

FIG. 1. N42/114 site plan, Alberon Street park, Parnell.

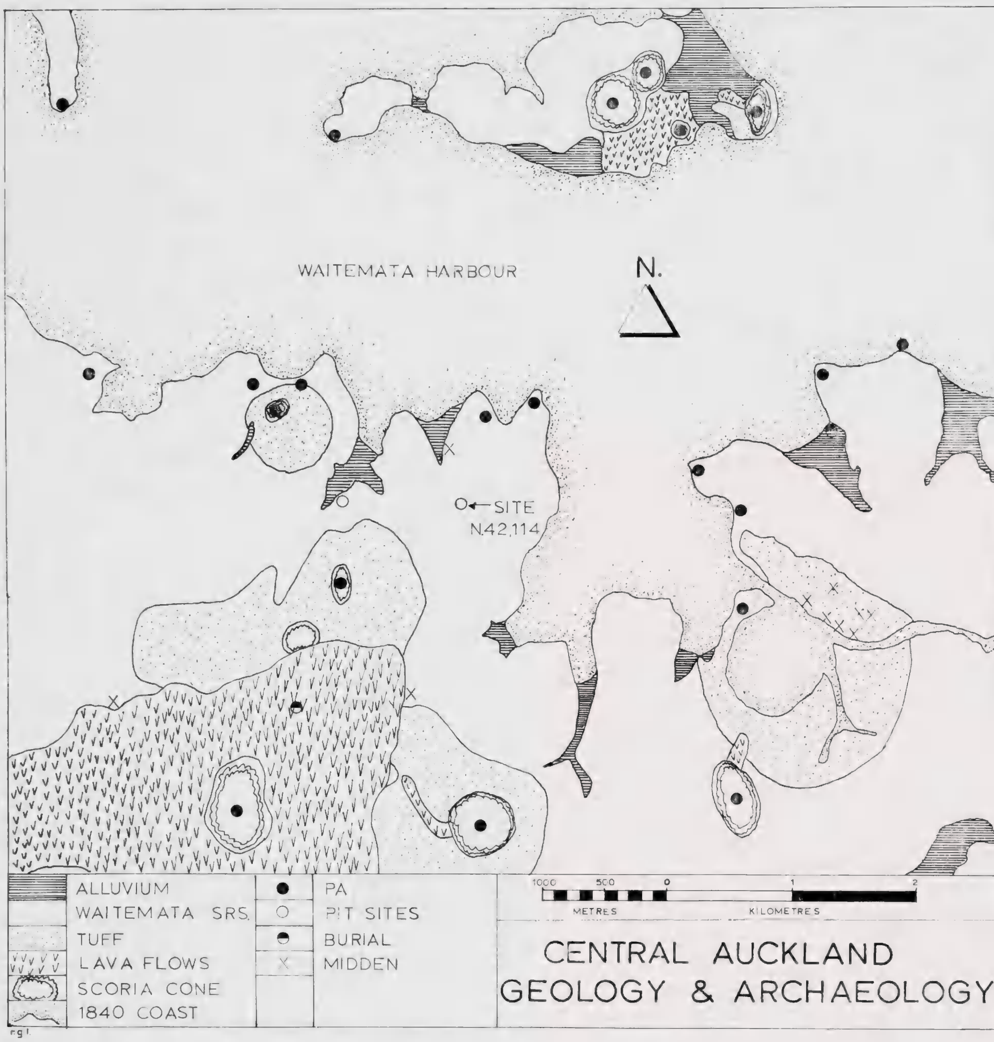

Fig. 2. Central Auckland geology and archaeology.

EXCAVATION TECHNIQUE AND DESCRIPTION

A grid (Fig. 3) was set out over the two probable pits with the intention of excavating a quadrant of each and having a control section of the fill in both directions across the pits. However, the grid was misaligned because of the vague nature of the surface evidence. The quadrants were duly excavated. The technique was to turf each area to be excavated, define each pit outline in plan by excavation with a trowel, and sink a test hole to the floor also by trowel. The remainder of the pit fill was removed by cutting back the vertical face from the test hole with a spade while watching the section exposed. The final excavation of the floor, floor features and wall was by trowel. While this technique has undesirable features, it can be justified on rescue excavation as it is fast and, on this site, the stratigraphy of the pit fill had no cultural significance.

The stratigraphy can be summarised as follows:

Layer 1: Topsoil, rooty, organic and black, with inclusions of recent charcoal, continuous over the site.

Layer 2: Lens of recent charcoal, probably dating from the last clearance of the site, discontinuous and in pit 1 only.

Layer 3: Silt, organic, rooty, dark grey to dark olive, discontinuous, in pits only.

Layer 3a: Similar to layer 3, but with inclusions of layer 5 material and more organic towards the base (fill of European rubbish pit).

Layer 3b: Lens of charcoal in layer 3, discontinuous, and in pit 1 only, probably representing an early European clearance.

Layer 4: "Roll-in" material, silt, clayey, mottled light grey and yellow, with charcoal and bark inclusions, discontinuous and in pits only.

Layer 5: Natural silt, clayey, mottled yellow and light grey, with occasional fossil charcoal. This or similar layers extend 10 m or further until the parent rock is reached.

The cultural implications of this stratigraphy are trivial. The contacts between the layers were not sharp, the upper contacts in particular being worm-disturbed. The contacts between layers 4 and 5 were horizontal (i.e., the pit floor), and were well marked by texture changes and horizontal root traces. The vertical or near vertical contact at the wall was less well marked and some difficulty was encountered in establishing its position.

Floor features were also difficult to establish. The drains and some of the floor depressions were filled with a dark clayey silt which varied only slightly in colour and texture from parts of layer 5. The drain was well defined in other places, being filled with organic material. However, in places where it was not, organic fragments, apparently of bark, and charcoal flecks, helped to outline it. Some of the postholes were filled with a material of similar colour and texture, but small chocolate-coloured flecks of highly decomposed wood occurred. These flecks are probably the remnants of a post. Figure 4 shows the completed excavation from the south, with pit 1 on the left and pit 2 on the right.

Two test squares, x and y, were excavated on the flat areas. Square y was 2.5 m square, and sterile. Square x was 2 m square and, again, sterile. A thinner topsoil than was encountered elsewhere, a small pocket of commercial crushed rock and a 1947 sixpence in the topsoil, may indicate that the flat areas are quite recent. It is considered that the two test squares were sufficient samples of the flat areas to show that they are not prehistoric.

Subsequent to the completion of the excavation, a City Council contractor stripped the topsoil from the entire ridge. During this operation, the newly exposed surface was inspected for indications of other structures. No further pits were recognised, but to the south-west of the two excavated pits several postholes were encountered. This area had a marked cross-fall of about 1 in 8, but this may have been exaggerated by the bulldozing. The fill of the postholes was of two types. The first was identical to that of the pit postholes, and the second was a black organic

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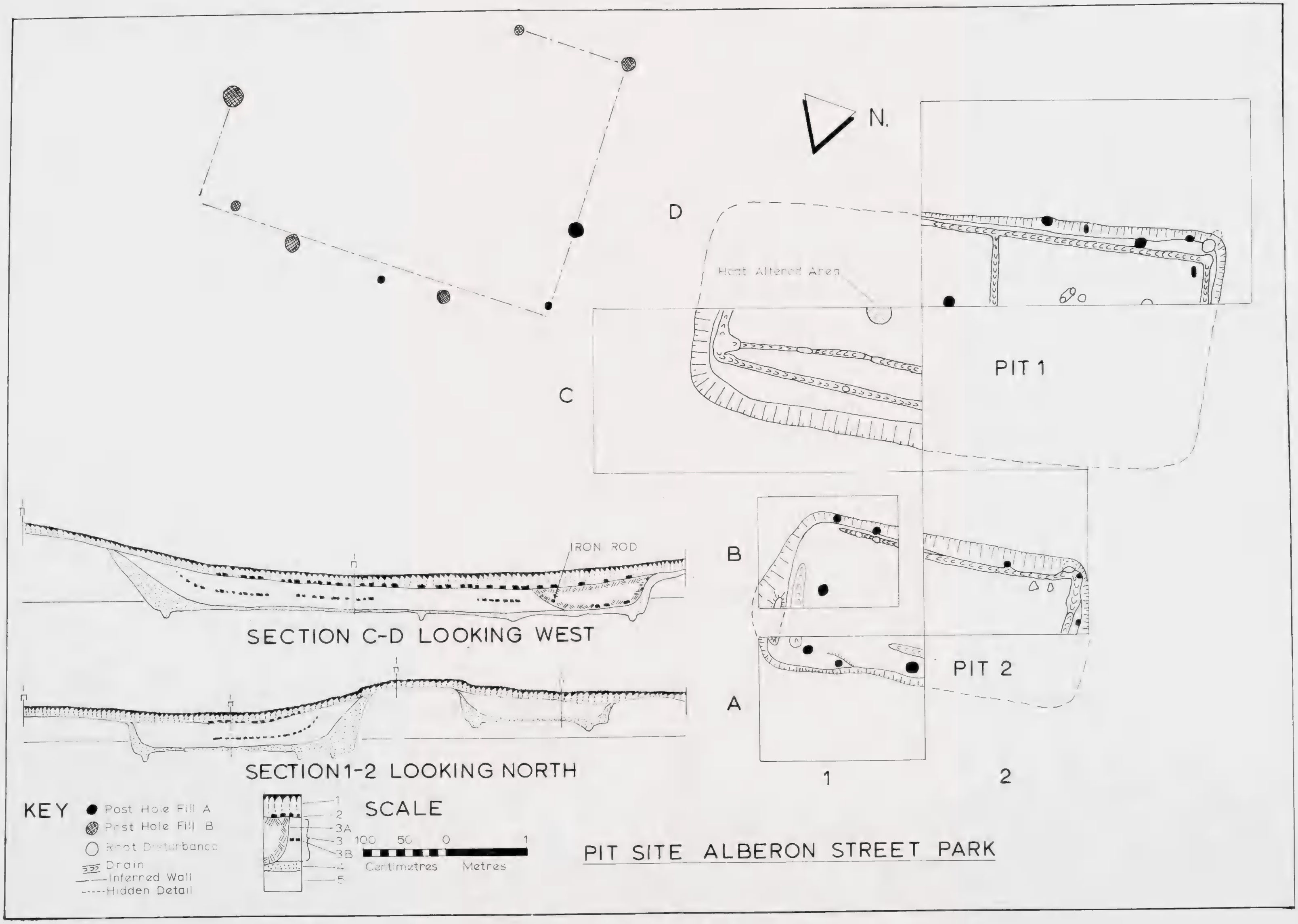

FIG. 3. Plan, principal cross-sections and key to the layers, pit site N42/114, Alberon Street Park, Parnell.

FIG. 4. The completed excavation from the south, showing pit 1 on the left and pit 2 on the right, site N42/114.

silt with inclusions of scoria up to 4 cm in diameter. This organic silt differed from the topsoil. Shallow pockets of similar material occurred in the subsoil, but these were too disturbed to record adequately. Similar sized pieces of scoria were distributed at random in the pit fills.

It is unlikely that scoria occurred naturally on the site. The nearest volcano, in the Auckland Domain, is one of the older examples (Searle, 1962, p. 200), and any ejected material on the surface would have weathered. The scoria found was in moderately fresh condition. The significance of the features encountered will be discussed in a later section.

Artifacts

Two small pieces of red ochre, *kokowai,* were encountered, one on the floor of each pit. No other prehistoric material was found. In the pit fill, and in the European rubbish pit, was a collection of European material including an iron rod, a broken brick, broken blue and white glazed pottery, and hand-made and modern beer bottle fragments.

Bark Fragments

As mentioned above, some material like bark was encountered in the fill of the drains. It was often lying in cylindrically curved sheets, the curvature indicating a diameter of about 10 cm. The material was 1 mm or less in thickness. The surface showed occasional dimpling, similar to that on the bark of a semi-mature kauri tree, *Agathis australis* Salisb. In constructing a pit, posts would be made most economically

from local trees. Saplings would provide straight posts of a suitable diameter. There would be little point in removing the bark, but as this sloughed off while the posts were in position, much of it would end in the drains. The survival of it in the heavy wet clay is unremarkable.

SITE INTERPRETATION

Indications of a central row of postholes supporting a ridge pole occurred in both pits. Wall postholes were found on both sides of the shallower pit, pit 2, and along the low wall of pit 1 (Fig. 5), but none along the high wall. It is suggested that the rafters rested on the ground on this postless, high side of the pit, and on a low timber frame supported by wall posts on the low side.

There was no indication in the pit fill that an earth cover was placed over the roof. No exit drains were found for the floor drains. The sump-like feature in the north-west corner of pit 2 did not readily allow water infiltration, rather collection, but the similar feature in pit 1 in the same corner was too high and protected by a lip, preventing drain water from entering it. It may be that the impracticability of these sumps was realised before they were completed. Similar recesses have been found in the walls of many *rua* (Groube, personal communication). The drain across the north end of pit 2, and the drain furthest from the wall in the south-east quadrant of pit 1, both exhibited slotlike features rather than evenly graded bottom. They may have held slabs, but these seem structurally unnecessary unless they formed some interior division of the pit into bins. It is more likely that the undulations resulted from the use of a digging stick.

On some sites (Daniels 1965, p. 100; Golson 1961a, p. 25) pairs of pits of unequal size have been interpreted as a house and storage pit complex. There is no evidence that either or both of these pits were occupied. No midden, ovens, stone fireplaces or fire scoops, artifacts, artifact production waste products, burials, or other evidence suggesting long occupation, have been encountered. Furthermore, there are few grounds for separating the pits on their internal features, or any other grounds except size. The conclusion must be that both pits and the site generally fulfilled a highly specialised function other than long occupation. This function is most plausibly storage.

The reason for the construction of two pits rather than one large pit has several possible explanations. The pits might not be absolutely contemporary, but represent the construction of a new store, adjacent to the first, to expand storage in a subsequent season. They may represent some minor kinship division of the group which constructed them. The storage may have been divided deliberately to minimise the risk of fungus damage in the kumara crop (Ambrose 1967). The exact alignment of the pits suggests, however, that they were contemporary.

If both stores were filled at the one time, an estimate of the quantity of food stored, and its food value in person days, is possible. Briefly, this can be done by computing the volume of the pit to ground level, allowing for non-used volume, converting this volume to a mass of kumara using known densities, allowing for some losses and seed storage, converting this mass to a calorific value, and dividing

FIG. 5. The north-west quadrant of pit 1 viewed from the south, showing floor drains, wall postholes, the corner excavation, root disturbance to the floor, and a pipe in the fill of the European rubbish pit protruding from the baulk, site N42/114.

the total by a figure for the average daily calorie requirement of a statistical mean person. The process is inevitably imprecise. A figure of 130 ± 65 person days per cubic metre of pit volume has been calculated as a reasonable estimate. The derivation of this mean and standard deviation will be published elsewhere. The volume of the pits is 13.7 m^3, storing 1780 ± 890 person days of food. The period between the growing seasons of kumara is about 7 months. If the store was consumed over this period, it would provide for a group in the range of 4 to 13 people. It should be noted that a total diet of kumara is not a balanced diet and other ingredients are required.

The fact that the site was not occupied suggests either that other food sources were used and attracted settlement elsewhere, or that defensive and social considerations demanded the presence of the owners elsewhere.

The postholes to the south-west of the pits suggest an enclosed rectangular area aligned with the pits. It is tempting to interpret this as a house, but the marked slope across the area, the lack of completeness of the pattern, and the absence of a fireplace or midden evidence, weigh against this suggestion. The disturbance by the bulldozer may, however, account for the lack of all but the last piece of evidence. If it was a house, it was possibly only a temporary shelter, used briefly at harvest or during the construction of the pits, which might account for its irregular form. Other possible interpretations are a *whata,* a stage for storing or drying food, which was used principally for fern root (Best 1916, p. 103), or some sort of enclosure, possibly surrounding a kumara propagation bed. This latter explanation might account for the scoria, as it was Maori practice to use similar material as a soil additive. None of these suggestions carries any great conviction, and the interpretation of this structure may be possible only after more comparative material is available. By its alignment, it is thought to be contemporary with the pits.

GENERAL DISCUSSION OF CLASSIC MAORI FIELD EVIDENCE IN THE AUCKLAND ISTHMUS

Surveys performed in the last 10 years in the Auckland district have shown a marked disparity in the nature of the known sites on the Auckland Isthmus. A suitable area for comparison is Motutapu Island, some 19 km from Alberon Park. No European housing development has taken place on the island, and a high percentage of prehistoric sites survives. With 74 sites recorded, including 16 middens, the ratio of defended to undefended sites (pits, terraces, and combination pits and terraces) is 1 to 2.5, and the density of undefended sites is 2.7 per km^2. On the Auckland Isthmus, in the area covered by Fig. 2, this ratio is 1 to 0.09, and the undefended site density is 0.06 per km^2.

The lack of undefended sites on the isthmus can be attributed to selective site destruction, as the defended sites are principally volcanic cones that have survived, at least in part, or sufficiently long to come to the attention of archaeologists before destruction. Because surviving undefended sites are now so rare, the excavation of the pits at Alberon Park was considered of high importance.

Studies of historical material have suggested that the late Classic Maori settlement pattern was dispersed hamlets with fortified retreats rather than inhabited fortifications (Groube 1964) and, further, that agriculture may not have provided a staple food supply (K. Shawcross 1967a, p. 345). If so, concentration of permanent settlement on suitable gardening soils would be unlikely. Historical evidence from the Bay of Islands (K. Shawcross 1967b, p. 221) and archaeologically recovered faunal evidence from Galatea Bay near Auckland (F. W. Shawcross 1967, p. 128) suggest seasonal movements of population, which is not consistent with permanent occupation of a pa. Although it has been suggested that the occupation of large pa of the isthmus may all be early (Groube 1967, p. 19), and some of the evidence suggests that the initial occupation was early (Golson 1961b, p. 51), the author believes that a large late occupation is not ruled out. Full exploitation of the high fishing, shellfish gathering and garden potential in the area may have resulted in the persistence of social groups, at least for defence, larger than those encountered in the rest of New Zealand, simply because the available defensive sites were suitable only for large nucleated pa where the usual breakdown into units (Buist 1965, p. 77), possibly with some social significance, was impossible. The social instability of this organisation in the face of intensive warfare in the 18th century may have resulted in the depopulation of the isthmus immediately prior to European settlement (Fowlds 1967, p. 9).

Undefended pit or pit and terrace sites are commonly considered to indicate the location of the hamlets suggested above. They would represent the maximum dispersal of the minimum kin groups. If this is so then, because of their kumara storage function, the hamlets must have been used from March onwards after harvesting, until the stored crop was consumed, and then again during November when the seed tubers were planted.

In the seasonal hypothesis outlined above, it is suggested that the summer, between planting and harvest, was spent fishing and shellfishing, some of the produce being dried for storage (F. W. Shawcross 1967, p. 114). The period before planting would be the preferred time for gathering fern root.

Rectangular pits, with a row of postholes and wall drains, are a type of very frequent occurrence, found over a large area of New Zealand. Functionally, they are most convincingly storage shelters for kumara. The other explanation, that of pit houses, has aroused some controversy, and has several inconsistencies (Law 1969a; Groube 1964; 1965, p. 80). Typologically, pits still await a major study and, regrettably, even description. With only one other Auckland provincial pit site fully published (Kauri Point undefended site—Green 1963), compiling any comparative data on pits will involve considerable further effort. Consequently, no comparison with other sites will be attempted at this stage.

Without wishing to define any types, the two pits excavated on this site can be compared with pits on other sites by their dimensions, posthole and drainage pattern, and the presence or absence of other internal features. It has been suggested that the presence of drains is unreliable as they were not needed in permeable soil types. Similarly in heavy intractable soils such as this site, pits may not have been excavated to the depths which have been found on the scoria cones where the soil is more easily excavated.

In a study of a pa site in South Auckland which had many pits (Law 1969b), the pits showed wide size variation, apparently related to the size of the group constructing them. Because of this, it was suggested that pit size may be a difficult feature to use typologically.

CONCLUSIONS

The site seems to have been the storage area of a fairly small group. It is certainly not a dispersed hamlet or a seasonal dwelling site for any period longer than the harvest. The dwelling site, at the time of storage of the crop, was either in a pa or in a hamlet close by, probably close to other food resources, most likely on the beach. This implies that three distinct sorts of site existed on the Auckland Isthmus, all possibly in use at crop harvest—pa, storage sites at the agricultural areas, and coastal exploitation sites. Combinations of two or more of these in one place are of course possible, and probably these would be the most favoured sites. For this reason it is dangerous to argue that all pa were not permanently inhabited as some were in zones favourable for several kinds of exploitation. Similarly it is dangerous to assume that all pit sites were inhabited, as some (such as this site) were highly specialised storage sites useful only for one form of exploitation in a zone.

This suggests that evidence of seasonal movements in prehistory, particularly in the Classic Maori period, may be relevant only to a small area, and that the dimensions of economic zones may be extremely limited, even down to a distance which can be covered on foot in a few hours.

ACKNOWLEDGEMENTS

Once again, it is a pleasure to thank Miss Janet M. Davidson for her help.

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SALVAGE EXCAVATIONS AT HAMLINS HILL, N42/137, AUCKLAND, NEW ZEALAND

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Abstract. Hamlins Hill is an extensive area of pits and terraces in South Auckland. Salvage excavations were conducted on a portion of the site about to be destroyed by quarrying. The interiors of several pits were partly exposed, revealing post-holes, and drains sometimes covered by stone slabs. Evidence of several surface houses and a cooking area was uncovered in a portion of the site unmarked by surface features.

Hamlins Hill rises to 200 feet (61 m) east of Southdown Railway Station and the Great South Road on the isthmus between the upper reaches of the Manukau Harbour and the Tamaki River. The portage linking the Manukau and Waitemata harbours passed south of Mount Richmond and the McLennan Hills, two volcanic cones nearby.

The area is one of considerable geological complexity. Hamlins Hill is surrounded by basalt derived from Mount Wellington, while immediately to the south, Mount Richmond and the McLennan Hills are surrounded by volcanic tuff and ash. The district is predominantly one of fertile volcanic soils, although Hamlins Hill has a relatively poor clay soil.

The site is well placed for the exploitation of various sea resources. Extensive shellfish beds exist in the nearby Manukau Harbour and Tamaki River; easy canoe landings on the isthmus provide ready access to the more distant sources of sea food. Another attraction of Hamlins Hill itself is the presence of a small, permanent spring of fresh water.

The archaeological importance of Hamlins Hill has long been recognised. It is the only surviving large site in the Auckland area located on a clay, rather than a volcanic hill. Moreover, the gently rolling hillside, and the lack of artificial defences, set the site in a separate category from the steeper and often definitely fortified volcanic cone sites. In 1964, a detailed map of all surface features visible on the site was prepared by Miss M. Nicholls (now Mrs. Hougaard) and members of the Auckland University Archaeological Society. This map is reproduced in Fig. 1, where it can be seen that the site consists of a scatter of pits and terraces dispersed over a considerable area.

In late 1968, it was learned that the smaller knoll to the south of the spring was to be quarried for spoil. No definite estimate could be obtained of the amount of time remaining before all or most of the surface features in this area would be destroyed. With the co-operation of the owner, the Auckland Meat Co., and the quarrying agent, W. Stevenson and Sons, a small rescue excavation was arranged and

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carried out during two weeks in February 1969. This was the only time when student labour was available. A small team, approximately six people at any one time, worked on the site.

THE EXCAVATIONS

The site is very dispersed. Time did not permit a full area excavation even of a portion of it, although the relatively simple stratigraphy makes it highly suitable for area excavation. All that could be done was to obtain a sample of the interiors and features of the many pits visible on the surface, and to test one of the extensive flat areas which are interspersed with the pits. With these aims in view, a base line was set out which ran across the central flat and through the two pits, A and B, the former of which is the largest in this part of the site. Quadrants were set out in the two pits, and opposing quadrants excavated, thus providing longitudinal as well as transverse sections through both pits. On either side of the base line, in the flat area above the pits, five squares were set out and excavated. One of these squares bisected a third pit, F.

A trench 10 m x 1 m was set out as a continuation of the longitudinal section through pit A, but at an angle to it. This trench was designed to test three pits, C, D and E. An extension of this trench was subsequently made to expose the end of pit D.

A rectangle 3 m x 4 m was set out on one of the terraces with the aim of investigating the central flat area and one of two pit-like depressions visible on it.

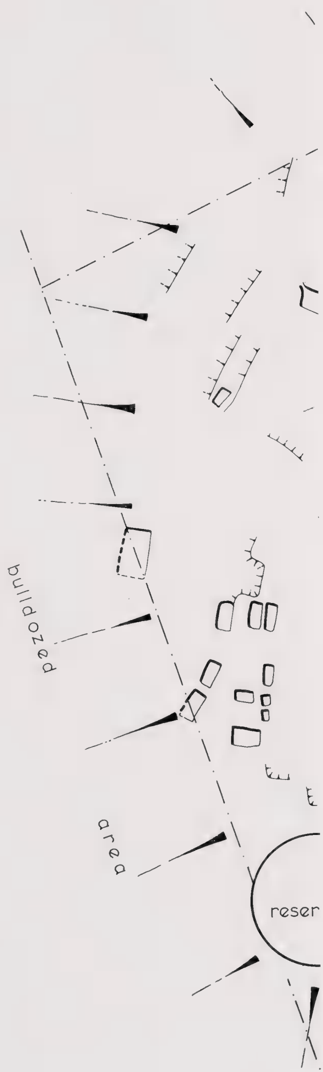
The plan of the area to be destroyed, as mapped in 1964, is reproduced in Fig. 2, with the excavated areas shown. Figure 3 gives a general view of the area involved after initial quarrying had taken place. Three pits on the northern edge of the knoll were affected by this stage of the quarrying.

The stratigraphy of the site was very simple. In the case of the pits, whose fills and features are described below, the principal problem was the removal of a sufficient amount of spoil in the time available to permit an adequate definition of features. The method adopted here was to turf the area to be excavated and remove topsoil, then to sink a test pit in the centre of the pit to establish the floor, and work back from the floor to the walls. Finally, postholes and drains in the floor were excavated.

In the squares, excavation was done by trowelling, and each quadrant was excavated and its contents analysed separately.

THE PITS

In all cases it proved possible to define the edges and floors of the pits and their features. All the pits were rectangular with drains around their floors, and postholes implying some kind of roof structure. The fills of the pits were simple, consisting generally of fairly hard clay fill on the floors and near the walls, overlain



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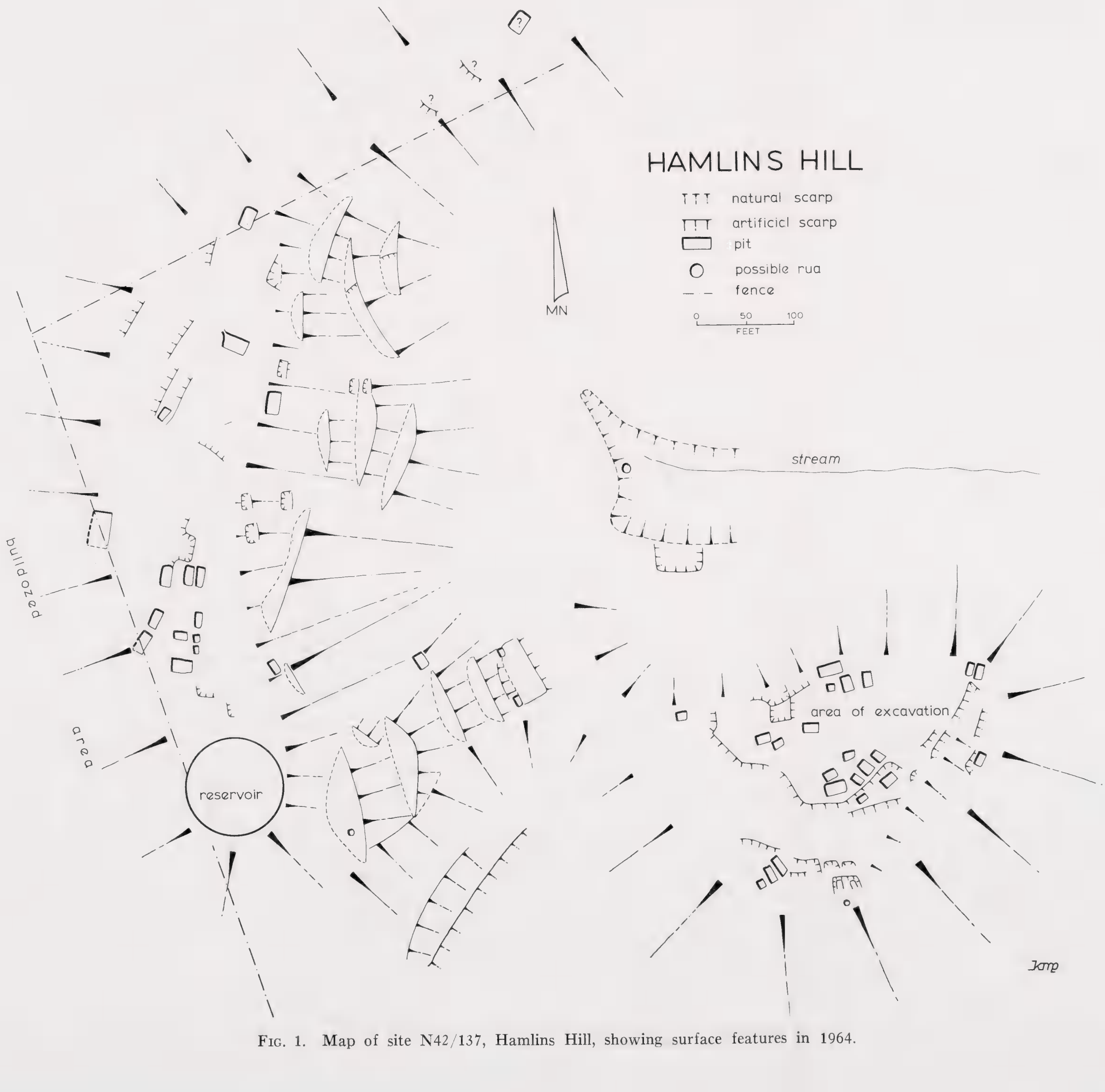

FIG. 1. Map of site N42/137, Hamlins Hill, showing surface features in 1964.

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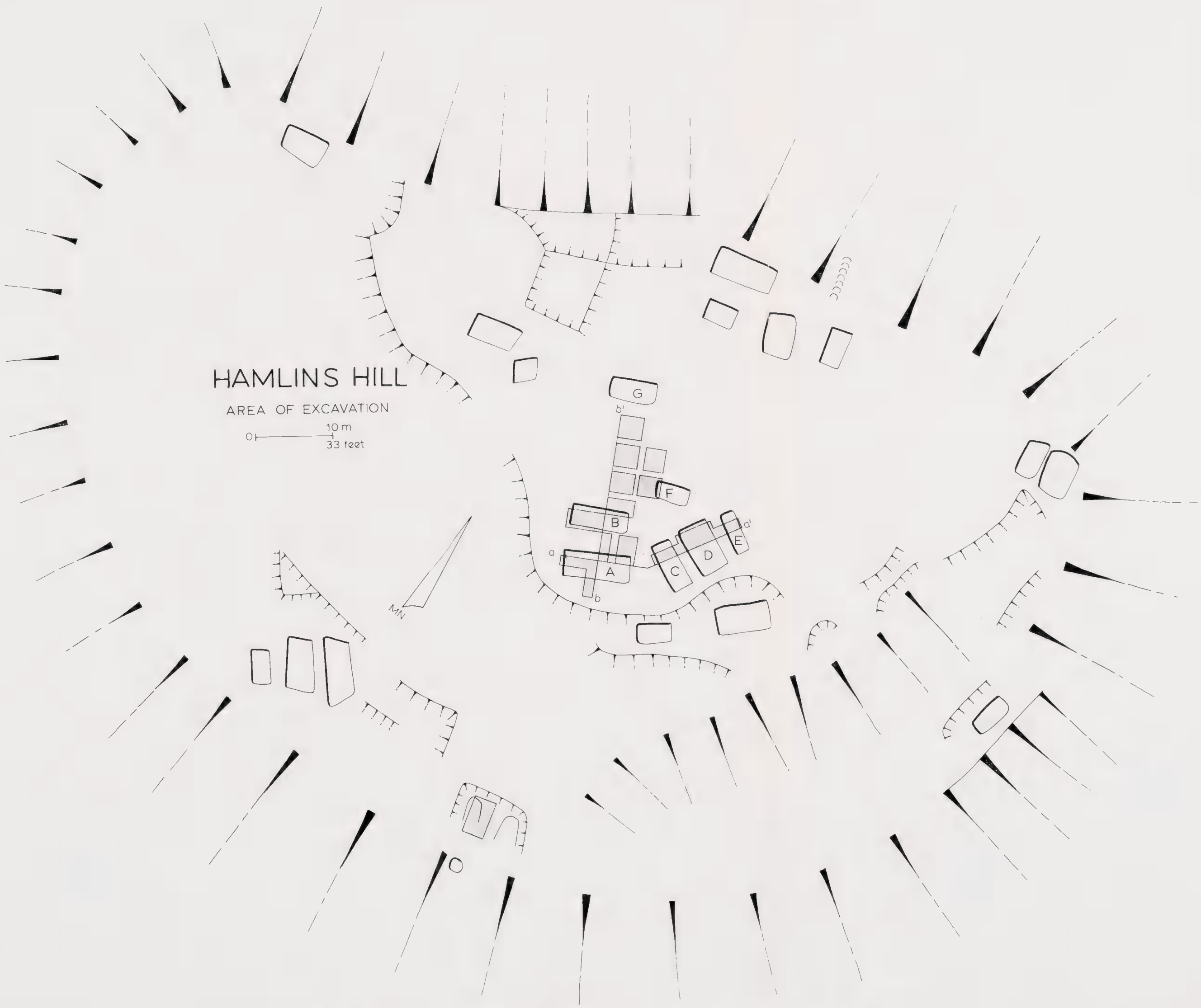
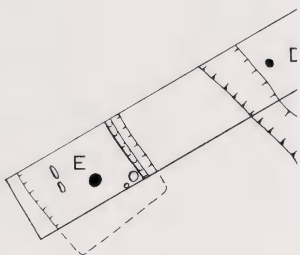


FIG. 2. Map of part of Hamlins Hill to be quarried, showing area excavated.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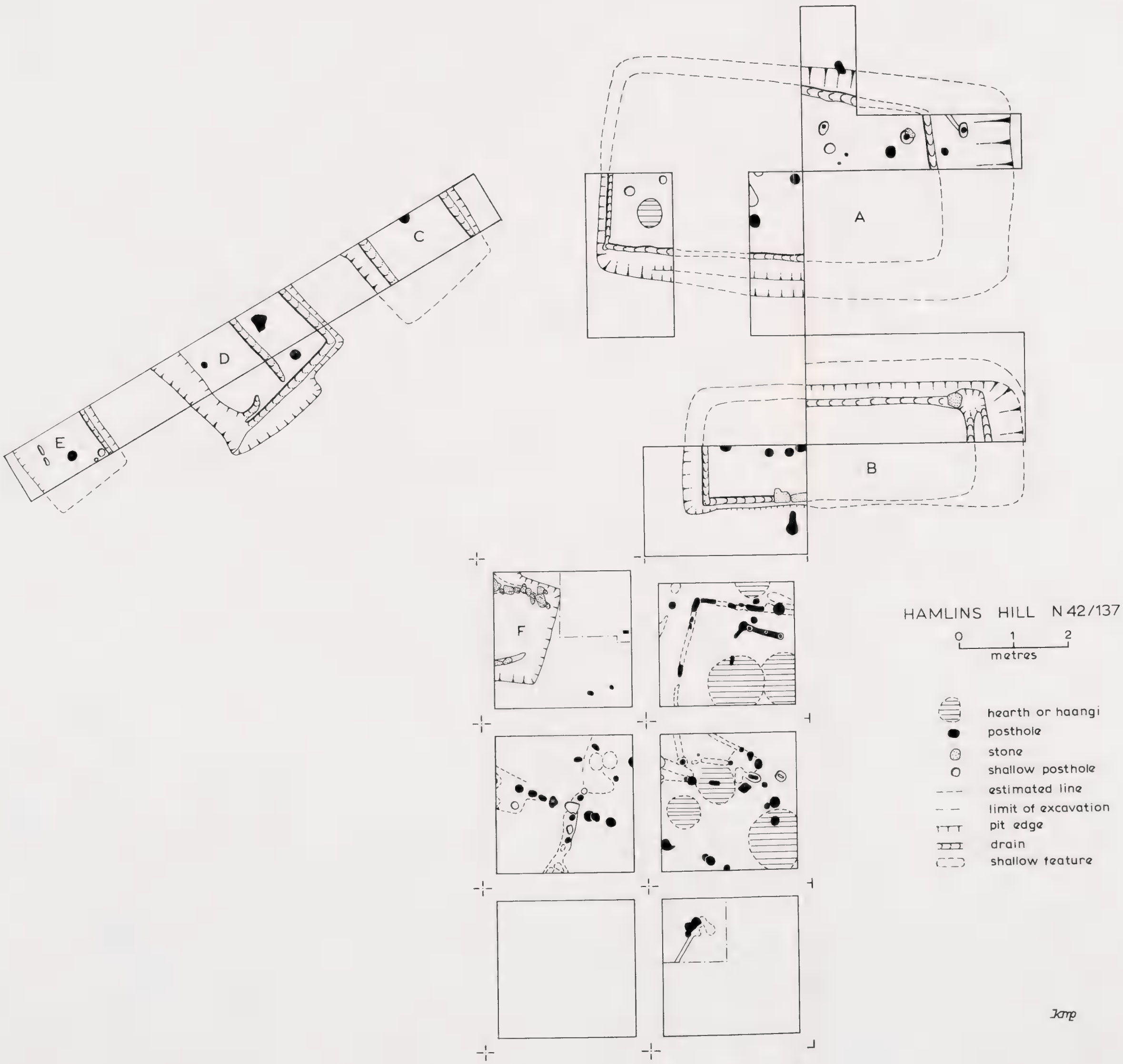

FIG. 4. Plan of features uncovered in excavation, Hamlins Hill.

T 4

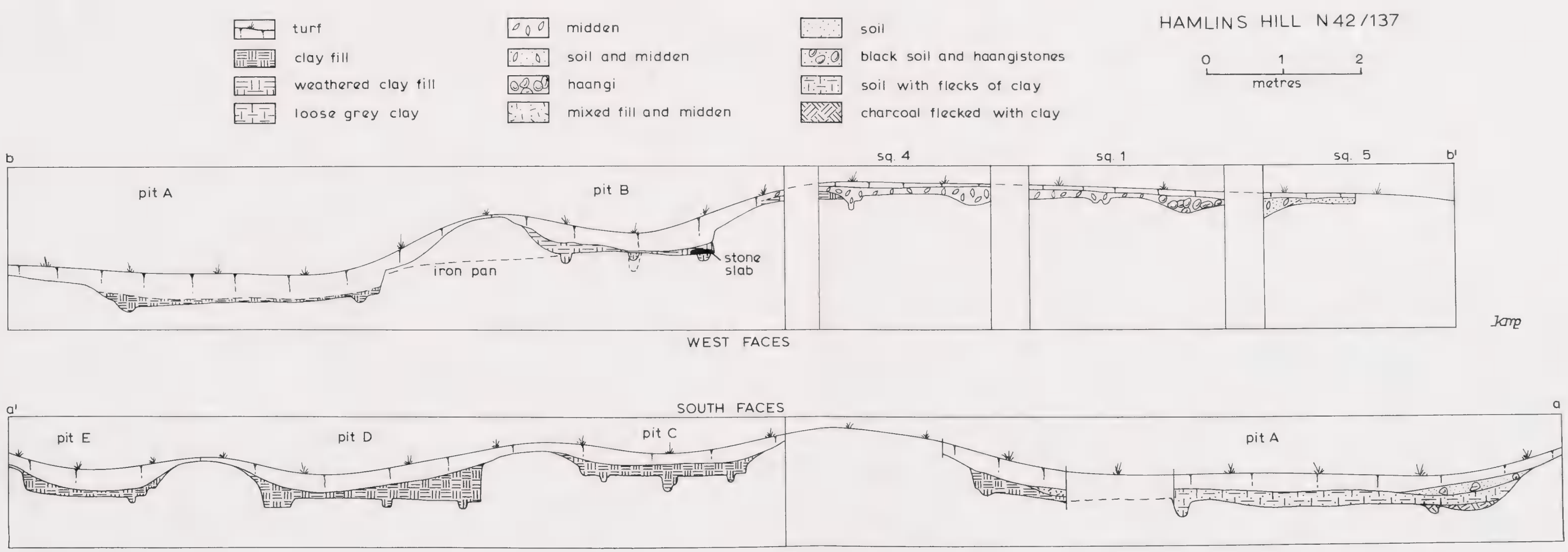

FIG. 5. Principal cross-sections, Hamlins Hill.

T 4

FIG. 3. View of part of Hamlins Hill during excavation.

by more humic material. Occasional pieces of obsidian occurred in the pit fills. No layers were continuous through more than one pit except the topsoil. The ground plans of all pits excavated are shown in Fig. 4, while representative cross-sections through them appear in Fig. 5.

PIT A

This pit was so large that it was not possible to excavate more than a third of it. It has a higher northern wall and a lower southern edge, with a rather uneven floor dipping considerably towards the centre and at one end. A shallow drain could be traced, slightly off centre, around the floor in most of the excavated portion. No clear posthole pattern emerged, but there was probably a central row of postholes and two parallel rows at either side inside the drain. A number of smaller holes of uncertain purpose were also located in the pit floor. There was no evidence of wall posts in the excavated portion. The postholes were filled with several rather different materials suggesting more than one phase of construction or use of the pit. A circular depression in the eastern end was filled with a compact mixture of ash, charcoal and clay.

The fill of this pit followed the general pattern, but was complicated by a lens of charcoal-stained clay on the floor at the western end, and a discontinuous layer of *haangi* material, charcoal and burnt stones, between the upper humic layer and the more clay-like fill of the pit. This *haangi* material appears to represent cooking activity considerably later than the construction and use of the pit itself.

Pit B Fig. 6

A more satisfactory pattern was obtained from the two excavated quadrants of pit B. This pit was a symmetrical rectangular pit with a fairly weathered edge. Again, the northern wall was higher, and was noticeably undercut in places. A pronounced, well-made, square-bottomed drain ran around the floor a few cm from the wall. For a portion of its length this drain was covered with flat slabs of vesicular basalt, deliberately placed over it. Some fragments of bark-like material, similar to those from Alberon Park (Law, this volume) were found in the drain.

Fig. 6. Pit B from the east at completion of the excavation, N42/137.

A single row of central postholes was found. All were filled with a fine dark soil. One posthole appeared at a level slightly above the actual floor, and may indicate re-use of the pit, or merely the longer duration of one of the posts after the others had decayed or been removed. An angled posthole in the northern rim of the pit suggested that a substantial beam had rested in it. If so, the angle of the hole indicates a rather steeply pitched A-shaped roof.

The floor of pit B partly coincided with a natural iron pan in the subsoil. This same iron pan occurred in the northern wall of pit A, where the pit had been dug through it. Differential weathering of the pit wall above and below the iron pan had occurred, the iron pan protecting the lower part of the wall and forming a sort of shelf (Fig. 5).

Fig. 7. Trench through pits C, D and E. Pit E foreground. N42/137.

Pit C

This small shallow pit appeared to follow a similar plan to pit B, with a drain around the edges and a central line of postholes. An insufficient area was exposed to provide any further details.

Pit D

Fig. 7, centre

The only instance of complexity of pit construction occurred in pit D, where two successive intercutting pits were found. The first version had been slightly shorter and broader, and had either a slightly off centre row of postholes or two parallel rows. This pit had been filled, probably deliberately, with a hard clay fill, and then a much narrower, and perhaps longer pit had been dug in the same area. Both pits had a single drain a few cm from the wall. On the east side of the pit these two drains had almost or completely overlapped, with the result that a single drain was revealed during excavation. The posthole pattern of the latter pit is doubtful, but was probably a single central row.

Pit E

Fig. 7, foreground

This was the smallest of the pits. A complete drain was found only on one side, although vestigial traces of a drain were found on the other side. The sides of this pit were low and eroding, but no traces of wall posts were found. Again, the posthole pattern seemed to consist of a single central row.

Pit F

Fig. 8

This pit differed from the others in several respects. The fill contained more fractured stone, and a little dispersed shell, presumably from the midden area nearby. The pit was basically rectangular, but its southern wall turned outwards, suggesting a possible corner buttress. The walls were low and rounded, and the floor sloped downwards towards the centre. The most remarkable feature, however, was the line of stones covering, and in some cases filling, the irregular curving drain. These stones were less regular, and less carefully placed, than those in pit B; the intention appeared to be the same, however. The drain in this pit also was less regular, resembling that from the later phase of pit D.

Discussion

The only pit of which a really adequate sample was exposed was pit B, which appeared to be rectangular, without buttresses, with a drain running into a sump in one corner, and with a central row of postholes. This type is widespread in the Auckland Province. An unusual feature was the partial covering of the drain with stone slabs. This has been reported only from Great Mercury Island, and from Ruarangi near Whangarei (Nicholls, personal communication), although the use of stone for construction purposes has been reported previously in the Auckland district from Mount Wellington (Golson 1960, p. 34).

Although other pits were not excavated to the same extent, largely because of lack of time and labour, some comparisons can be made. Pit C most closely resembles pit B in size and plan. Pits E and F are smaller, but follow the same basic plan,

while pit F also shares the unusual feature of stone-covered drains. It is difficult to be certain of the exact nature of pit D at either stage; the earlier version, not unlike pit B in size, seems to have two rows of postholes, perhaps because of slightly

FIG. 8. Stone slabs covering drain in pit F, after excavation. N42/137.

greater width. The later version probably resembled pits E and F. Pit A, the largest pit, seems probably to have had three rows of postholes. The possibility that this pit, too, saw two construction periods is suggested by the large number of postholes, and the difference in size and alignment of pit, and area defined by drains.

A similarity can be seen between the pits here and at other sites such as Taniwha Pa, where drained pits in clay with single or double rows of postholes, depending on pit size, and particularly width, occurred (Green 1963, p. 77). Similar patterns have been found at Bald Hill, South Auckland (McKinlay, personal communication), while less certain parallels also exist with pits on the volcanic cones of Mount Roskill and Mount Wellington (Golson 1960, Shawcross 1962). The absence of buttresses from this site should be noted, but at the same time, the only pit for which absence of buttress is certain is pit B.

While the difficulties of comparing pits at the present time are many, the fact that these pits show stronger similarities with pits in clay at sites such as Taniwha Pa and Bald Hill, and perhaps Harataonga Bay (Spring-Rice 1963), than they do with the nearer clay sites of Alberon Park and Motutapu, is worthy of note.

THE TERRACE

The least satisfactory section of the excavation was that carried out on the terrace to the south of the main excavation. The central part of the terrace proved to be an artificially levelled area which, however, was not particularly flat. One small stake hole was uncovered on this flat area. The stratigraphy consisted of a simple layer of soil overlying the clay subsoil; it contained no cultural material. On the downslope edge of the terrace, a rim of redeposited clay appeared. Only the edge of the pit-like depression lay within the excavated area. It contained a deep soil fill, at the base of which was a thin layer of *haangi* material. This in turn rested on a damp, compacted, clay fill which was extremely difficult to excavate. Owing to the lack of time, and difficulty of excavation, the base of this pit-like feature was not satisfactorily established.

It does appear that the terrace consisted of an artificially flattened area in the centre, and two pits, as was assumed during the mapping of surface features. The central area between the two pits does not appear to have been a house site. Because of their position at the base of a steep scarp, these pits have been subjected to a different kind of infilling process from those near the top of the hill; this made them very much more difficult to excavate. Their function, and the nature of the superstructure if any, remains obscure. Like pit A, this area seems to have experienced a limited re-use for cooking after the pits had been abandoned.

THE SQUARES

Five squares were excavated on the flat area. They were set out as 2.5 m squares with 50 cm baulks, and numbered in order of excavation 1 to 5. Squares 5, 1 and 4 are the three western squares, with 4 nearest to, and 5 furthest from pit B. Squares 2 and 3 are the eastern squares. Square 4 was slightly reduced in size to allow a baulk between it and pit B. Squares 1, 3 and 4 were completely excavated, together with three quadrants of square 3 and half of square 5. The stratigraphy was uniform throughout the area, and consisted of a thin layer of topsoil without cultural material, then a layer of dark sooty soil with shell midden, some bone, and several *haangi*, overlying clay natural in which a number of features had been dug.

The shell midden and the *haangi* pits were concentrated in squares 1 and 4. The midden became thinner and more dispersed in the north of square 1 and in the western halves of squares 2 and 3, giving way horizontally to brown soil in the eastern parts of these squares and in square 5.

Midden

During excavation, attempts were made to save as much of the midden as possible. The material was not sieved however, which means that retention of larger or smaller fragments was essentially arbitrary. In the denser midden areas of squares 1 and 4, excavation proceeded by quadrants, and midden from each quadrant was separately bagged and analysed.

Only a cursory analysis of midden has been undertaken, as it has seemed more important to describe the features uncovered on the site, than the economy which, under the circumstances, was poorly sampled. The midden taken from the excavation

is stored in the Auckland Museum, where it is available for more sophisticated analysis if required. The excavation techniques, however, necessitated by the nature of the salvage operation, may have rendered the samples inadequate for further study.

The shells present in the site have been identified, and a rough indication of their relative proportions gained by counting a minimum number of individuals of each species. The predominant species were bivalves. Individual shells were counted, but time did not permit a division into right and left. The number of animals represented is therefore only approximately half the number of shells counted.

The number of shells from each area of the midden is given in Table 1. From this it can be seen that the density of shell varies considerably, even within squares. The proportions of individual species fluctuate slightly, but the relative importance of the principal species remains the same. In all areas *Chione stutchburyi* is the most important species, followed by *Amphidesma australe* and *A. subtriangulatum*. In both the former species a considerable size range was present, from larger than modern shells to numbers of very small specimens. The shells of *Amphidesma subtriangulatum,* however, were consistently average size or larger. This may reflect more selective gathering or a different composition of the beds. It is also likely that *A. subtriangulatum* would have to be gathered further from the site than the other two species.

Several other shells of mudflat habitat, occurring in the midden, may be the result of indiscriminate gathering rather than actual food species. The shells of *Amphibola crenata* are almost all minute; although this shell was eaten in some localities, it seems unlikely to have been eaten here. Similarly, the various examples of *Cominella* and *Zeacumantus* appear to be incidental to the main composition of the midden. The only other mudflat shells which appear to have been gathered as food are scallops, *Pecten novaezelandiae,* which are present in very small quantities throughout the midden, although in one area a substantial number did appear, and perhaps *Cyclomactra ovata* which, however, is present only in small quantities.

There is a very small but persistent constituent of rocky shore shellfish, including *Lunella smaragda, Perna canaliculus, Crassostrea glomerata* and *Haustrum haustorium,* the latter represented by only one or two examples. Another rarity, possibly brought in with a kitful of *Amphidesma subtriangulatum,* was a single shell of *Dosinia* sp.

The total quantity of shell midden was not great, and does not appear to reflect the consumption of large amounts of sea foods. It is difficult to determine the presence of midden from surface inspection in this site, however, and it is impossible to decide how extensive the midden areas may be. The shell itself indicates predominant reliance on local tidal mudflats, and fairly indiscriminate gathering of *Chione stutchburyi* and *Amphidesma australe* therefrom; a suggestion that slightly more distant resources were exploited is provided, however, by the limited occurrence of rocky shore species, and the persistent occurrence of *Amphidesma subtriangulatum.*

Many of the shells in the midden are complete or nearly so; the *Amphidesma* shells, however, and to a lesser extent the *Chione,* are badly chipped and broken around their outer edges.

A small quantity of fish bone was recovered from the midden. This may represent half a dozen fish or less. As a rough indication of the distribution of the bone in the midden, numbers of bones recovered from each area are given in Table 2. These are

TABLE 1

MINIMUM NUMBER OF SHELLS IN MIDDEN, N42/137

	SQUARE											
	1				2	3		4				
SHELL	E	S	W	N		W	Pit	E	E*	S	W	N
Chione stutchburyi	387	193	90	42	280	59	340	308	154	877	171	186
Amphidesma australe	83	34	13	4	38	4	42	104	40	485	43	20
A. subtriangulatum	22	11	4	—	9	1	3	48	6	49	8	5
Amphibola crenata	28	14	13	4	16	—	34	19	9	101	12	7
Zeacumantus sp.	—	1	—	—	—	—	1	—	—	3	—	—
Cominella spp.	2	1	—	—	3	1	5	5	—	9	3	—
Zediloma sp.	1	—	—	—	1	—	—	—	1	1	—	—
Pecten novaezelandiae	—	1	1	1	1	—	1	4	1	24	1	2
Cyclomactra ovata	—	—	3	—	—	—	3	1	1	3	4	4
Maoricrypta sp.	—	—	—	—	—	—	—	1	—	—	—	—
Anomia walteri ?	4	1	—	—	—	—	—	1	—	—	—	—
Lunella smaragda shell	1	3	—	—	3	—	2	2	2	11	1	1
opercula	4	2	—	—	1	3	8	—	—	7	3	—
Crassostrea glomerata	—	—	1	—	1	1	1	1	—	—	—	1
Perna canaliculus	—	—	—	—	—	—	1	1	—	1	—	—
Haustrum haustorium	—	—	—	—	—	—	—	1	—	—	—	—
Dosinia sp.	—	—	—	—	—	—	—	—	—	1	—	—

* From fill of features at base of deposit.

TABLE 2

NUMBER OF FISH BONES AND PRESENCE OF OTHER BONE, N42/137

BONE	SQUARE 1 E	S	W	N	2	3 W	Pit	4 E	E*	S	W	N
Fish bones	14	27	12	—	87	—	—	149	14	208	19	15
scales	—	1	—	—	—	—	—	—	—	5	—	1
jaws	2	1	—	—	4	—	—	1	—	1	—	—
Dog	—	—	?	—	x	—	—	x	—	x	?	—
Rat	—	—	—	—	x	—	—	x	—	—	—	—
Bird	—	—	—	—	x	—	—	?	—	—	—	—

* From fill of features at base of deposit.
x = present.
? = identification uncertain.

TABLE 3

WEIGHT IN KILOS OF UNWORKED STONE, N42/137

SQUARE 1 E	S	W	N	2	3 E	W	N	4 E	S	W	N	5 E	S
39	25	45	30	38	6	5	5	25	30	22	36	5	1

nearly all spines. The few jaw bones recovered suggest snapper and barracouta. Very few scales were found, and very few head bones. Little can be said about the fishing habits and resources of the former inhabitants of the site on the basis of so small a sample.

Parts of two rat skeletons were recovered from square 2, and one rat canine from the south-east quadrant of square 4. A very small amount of dog bone was present in the site, and may represent one individual. A few small shaft fragments may be bird bone. No human bones or teeth were recovered.

The amount of midden may represent, at most, portions of one dog, one or two birds, two or three rats, and between three and six fish, together with a fairly small amount of shell. The total area of midden was not exposed, but surface indications and the excavated evidence suggest that it was a localised deposit of which perhaps between one third and one half was excavated. The number of *haangi,* however, appears to be greater than would be needed to cook the food represented in the midden, and it may be assumed that vegetable foods formed a substantial part of the total food cooked on the site.

Haangi

Some seven separate *haangi* pits were uncovered in the midden area, three in both square 1 and square 4, and probably at least one other in the latter square. These were not all contemporary; particularly in square 4 two or three successive *haangi* could be identified in the northern part of the square. It would seem that the area had been used for cooking on several occasions, but that only one or two *haangi* were in use at a time. Only two *haangi,* one in each square, were found with stones in them as they had last been used. The other *haangi* pits were identified as basin-shaped depressions, often with burnt clay in the base, which were, however, filled with more general midden debris. *Haangi* stones were dispersed through the midden deposit. Weights of stone from various parts of the midden are given in Table 3. Another feature of the midden area was the presence of lenses of clay near the *haangi* depressions, possibly representing material dug out in their construction, and clusters of stones, particularly in association with the southernmost *haangi* in square 4, possibly representing rake out from it.

Structural Evidence

Beneath the midden layer, a large number of postholes had been dug into the natural clay. In contrast to the situation in more complex sites, these formed several recognisable structures, although there were also a number which could not be accounted for. The plan of these features appears in Fig. 4. The postholes were filled with a mixture of clay and midden in most cases. Although they were not identified until the midden layer had been removed, it is possible that some were contemporary with, or later than, the midden. In each case where a posthole and *haangi* pit are superimposed, however, the *haangi* clearly seals and postdates the posthole.

Evidence of rectangular surface house structures was uncovered in square 4. These appear to have been constructed of a series of slabs set at varying depths into the ground, interspersed with sections of wall of lighter construction marked only by

a shallow channel a few cm deep. The depths of the slab-shaped postholes vary from 10 cm to 29 cm. Round postholes also occur, usually 30 cm or more in depth, in positions where they may be corner posts, door jambs, or central ridge supports. The walls are most substantial on the south side, and the patterns tend to become confused in square 1, where later postholes associated with the cooking area may also be present.

FIG. 9. Square 4 from the south-east, showing house outlines and *haangi* depressions, N42/137.

Several alternative alignments can be suggested. There are definitely two superimposed houses present and, probably, three. The two more definite structures can be seen in Fig. 9, together with later *haangi* depressions, which have disturbed the original house floors. No stone hearths were found, nor any stones which might have belonged to such hearths.

A further interesting feature of this area was the presence of one and, perhaps, two fairly substantial fences. The more definite of these runs diagonally across squares 1 and 2, and consists of an alignment of ten postholes ranging in depth from 20 to 50 cm. The majority are 30 cm or more in depth (Fig. 10). This line marks the approximate boundary of both the structural evidence and the midden deposit. Trace of an indeterminate structure was found in square 5, but this square contained markedly less cultural evidence than square 1. In square 2, almost at right angles to the first fence line, a shallower line was found. This could represent another house wall, but the unevenness of the surface in this area, compared with square 4, suggests that it may be another fence line.

FIG. 10. Line of postholes apparently representing a fence, square 2, N42/137.

The discovery in this area of a stockade or fence, and several house structures, as well as the cooking area with its superimposed *haangi,* indicate the value of a relatively uncomplicated site for the elucidation of settlement patterns and the discovery of structural evidence. Continued occupation and re-use of this area would have obscured more and more the significance of various postholes. Even with the present evidence, the exact relationship of various features is in doubt.

There is no doubt that at least two successive houses were built, and subsequently replaced by a cooking area, which was used over some extended period of time by a small group, rather than for a single feast. Whether the stockade relates to the house, the cooking area, or both was, however, impossible to determine, as was the relationship of the second possible fence line to other features.

ARTIFACTS

Artifactual material found in the site was extremely limited, and consisted mainly of obsidian flakes.

A fragment of a sandstone grindstone was found in the east quadrant of square 3, near the base of pit F. It measured 8.2 cm wide and 3.7 cm thick, and had broken in half lengthwise so that the existing fragment measured 7.1 cm in length. One surface was smoothed and concave as a result of grinding. Two small stone flakes with no evidence of use were found in the midden in the west quadrant of square 3.

A fragment of a stone adze was found in the midden in the south quadrant of square 4. It is the butt end of a small quadrangular-sectioned adze of a dark fine-grained stone, which had been worked by flaking and grinding, but was not completely ground. It appears to be from a wider adze which had broken in half longitudinally and had been reworked to form a narrower tool. The width is now 2.2 cm, thickness 1.2 cm. The length of the fragment is 2.6 cm.

An unusual flake tool was found in the fill of pit A, at the base of the topsoil. It is a fairly substantial greywacke flake, one side of which has been worked to a point. The point is ground on the sides and tip. The length of the flake, perpendicular to the striking platform, is 3.7 cm, and width 4.5 cm.

Fourteen pieces of obsidian were found in the excavation, including both grey and green varieties. More obsidian was found in or near the pits than in the midden. One small flake of green obsidian was found in the south quadrant of square 4, and one grey flake in each of the east and west quadrants. One large grey flake came from the east quadrant of square 1, and a small chip from the west quadrant.

Two flakes of grey obsidian were recovered from the fill of pit F. One showed tiny chips indicative of use on the edge. A grey flake with use marks was recovered from the fill of pit B at the base of the topsoil, while a flake of green obsidian, also with use marks, was found resting on the clay natural near the top of the wall of pit E.

The greatest concentration of obsidian was in the south quadrant of pit A. Two grey flakes, one with a rough face, were found in the upper portion of the fill. A

small green chip was found at the same depth as the greywacke artifact described above, while a small green flake, and a chip of grey obsidian with one rough surface, were found deep in the bottom fill of the pit.

The artifactual material is very restricted in comparison with that recovered from the two Motutapu settlements, N38/37 and N38/30 (Davidson, Leahy, this volume). It indicates merely that a few tools were present on the site, although little or no tool-working seems to have taken place. The inhabitants seem to have taken almost all tools and other items with them when they departed, and perhaps did not occupy the site long enough for many items to be lost or broken on it.

DISCUSSION

The problems of relating pits and other features in areas not directly linked stratigraphically have been discussed already in preceding papers in this volume. On this site, too, stratigraphic evidence to link the various excavated features in a tight chronological sequence is lacking. The pits A - E, which appear to have filled largely by natural processes, and which for the most part lack cultural material in their fills, must be late features on the site. If pit B, for instance, was earlier than the midden built up in square 4, some midden material would surely occur in the fill of the pit. On grounds of alignment, pits A and B are probably contemporary or nearly so; similarly, pits C - E seem to form a planned group. Whether or not all five are part of a single contemporaneous unit cannot be determined on the evidence available. Pit F, on the other hand, appears to be earlier than the midden build up, which forms a substantial part of its fill.

The earliest activity on the site appears to be the construction of several houses in the vicinity of squares 4 and 1, possibly associated with pit F, and perhaps also pits C, D and E or, at least, the earlier use of pit D. While this association of surface house and subsurface pit is not proven stratigraphically, it is at least probable.

The houses and pit F gave way, at a later period, to the intensive use of the flat as a cooking place, which is probably contemporary with the construction and use of pit B, for the midden does not appear to have been cut through or truncated by the construction of the pit.

It has always been assumed that Hamlins Hill is an "undefended" site or sites, although the possibility exists that there was a fortified point where the reservoir is now located. The line of postholes found in squares 1 and 2 suggests that the excavated area was surrounded by a palisade substantial enough to qualify for that name. This could have been intended as a wind break, or to keep dogs out, or to separate one domestic group from another if several portions of the hill were occupied contemporaneously. At the same time, there is the possibility that it was a minor defensive device.

There are three separate components involved in occupation of this area. Although no more than two at a time can be shown to be contemporary, it is likely that, at any one time, all three were present. The three components are the subsurface

storage pit, the surface house, and the cooking area. These three are the elements postulated for the domestic and communal units of Maori settlement by Groube (1965). Within the excavated area, it appears that all three were present, and that during several successive occupations of the same place the internal arrangement of these elements altered slightly.

The excavated sample is too small for confident extrapolation to other unexcavated portions of the site. The manner in which the cultural deposits peter out in the north of the excavated area suggests, however, that the group of pits investigated forms a separate unit from pit G and other pits in the site. It could be argued that the site represents a series of small hamlets, perhaps occupied successively, rather than contemporaneously, by a small group or several small groups over a period of time.

Despite the limitations imposed by the small area excavated, it is possible to infer that Hamlins Hill was the site of small villages or hamlets, which contained storage and dwelling structures as well as cooking areas. The storage pits are typical of many found throughout the Auckland Province and in some cases, such as Alberon Park (Law, this volume), they are not found associated with any domestic debris. At this site, however, other activities appear to have been associated, suggesting that the site was a village or hamlet, or series of such hamlets, rather than a specialised storage area.

Every new excavation in the Auckland district, particularly on small sites, adds to our knowledge of the nature of settlements. The presence of surface houses is now well attested. The Hamlins Hill houses, while less substantial than that uncovered by Groube at Orakei (Groube, personal communication), are more substantial than that found by Leahy at Motutapu (Leahy, this volume). They are very similar to houses uncovered recently on small pa in the Waikato Basin (Bellwood 1969; Peters, personal communication). It is interesting that both the house structures and the pits on this site seem to have their closest parallels with sites further south, and show only general resemblances to the Motutapu sites. Whether the differences are regional or temporal is uncertain.

The artifactual material was too restricted for any cultural assessment. The structural and economic evidence from the site suggest, however, that it belongs to the Classic Maori Phase.

CONCLUSIONS

Hamlins Hill is ideally suited to extensive area excavation designed to uncover features over a wide area. Excavation on a sufficient scale was not possible during the limited time available for the salvage project. At the time of writing, little further quarrying has taken place and it is hoped that some further work may be carried out before the area is destroyed. Even if this is not possible, the upper part of the site will remain for some time to come and further work should be carried out there to take advantage of the relatively simple stratigraphy and extensive structural evidence contained in the site.

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JOHN EDGERLEY, BOTANIST, IN NEW ZEALAND

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Abstract. John Edgerley collected plants in New Zealand for Mr. A. B. Lambert and the Earl of Mountnorris from 1835 to 1841. He was a nurseryman at Newmarket, New Zealand, from 1843 to 1849.

John Edgerley[1] was born about 1814.[2] He arrived at Sydney with Lieutenant Thomas McDonnell, R.N.[3], on 10 May, 1835, by the sailing ship *Emma Eugenia* from the Downs.[4] McDonnell had been appointed an additional British Resident in New Zealand[5], and he reached his property at Horeke, Hokianga, on 30 July, 1835[6]. He employed about 12 men at Horeke[7] and one of them, John Edgerley, had the duties of gardener and botanist[8].

The place and date of Edgerley's arrival in New Zealand were recorded[9] as "Bay of Islands, 1836", but the vessel in which he came from Sydney was not listed. Probably, he arrived at Hokianga with McDonnell in July, 1835, and visited the Bay of Islands in 1836.

Rev. James Buller, who saw McDonnell's establishment at Horeke in 1836, described it as the largest timber depot on the Hokianga. He recorded[10] that Lieutenant McDonnell

> "owned a large tract of broken country by virtue of purchase; he had built two vessels in his yard, and he lived in a good house, with gardens around it of some pretensions. Mounted on an elevation, he had several pieces of cannon, and the booming of their report would sometimes echo along the surrounding hills. Rafts of long spars, or of sawn timber, were floated down to the ships—the former to be taken to England, the latter to New South Wales . . . There was likewise some trading in flax and potatoes."

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1. Sometimes spelt as Edgerly, Edgeley, Egerley, and Egerly.
2. On his death in 1849, John Edgerley's age was given as 35 years.
3. Sometimes spelt as McDonnel, M'Donnell, and Macdonnell.
4. *Sydney Herald* 11 May 1835; *The Australian* 12 May 1835.
5. Right Hon. T. Spring Rice to Governor Bourke, 8 July 1834, in *Historical Records of Australia* Series 1, 17: 472, 1923.
6. Thomas Macdonnell to Richard Jones & Co., Sydney, 17 September 1835. Original in the Mitchell Library, Sydney, Riley papers - documents 1817-1856, A 109, pp. 89-96; photocopy in the Auckland Public Library.
7. Ibid, postscript.
8. Thomas McDonnell to Mr. Aiton, Kew, 16 November 1841. Original in the Library, Royal Botanic Gardens, Kew.
9. Leys, T. W. (editor) *Early history of New Zealand.* From earliest times to 1840, by R. A. A. Sherrin. From 1840 to 1845, by J. H. Wallace. H. Brett, Auckland (Brett's Historical Series). 728 + xliv pp. 1890. p.ii, entry as "Egerley, John".
   Auckland Provincial Centennial Council. *Roll of early settlers and descendants in the Auckland Province prior to the end of 1852.* Centennial Memorial Publication. Whitcombe & Tombs Ltd., Auckland. 260 pp. 1940. p. 72, entry as "Egerly, John".
10. Buller, J. *Forty years in New Zealand.* Hodder & Stoughton, London. 503 pp. 1878. p. 28.

Rec. Auckland Inst. Mus. 7: 123-136 March 31st 1970

v

Edward Jerningham Wakefield visited Horeke in 1839, and wrote[11] that

"a nice wooden house, belonging to Lieutenant Macdonnell, stood on a terrace about fifty yards back from the river. Mr. Mariner [his agent] had a comfortable cottage on the bank below, buried in the midst of flourishing gardens. The fig and prickly pear were growing well in the open air; and a vineyard, with three hundred and fifty vines of different sorts, promised great things . . ."

Rev. Richard Taylor, who visited Mr. Mariner on 22 February, 1841, noted[12] that there was "an excellent garden containing many of the New Holland flowers and shrubs."

In November, 1835, McDonnell set out to explore the Kaipara Harbour on the West Coast of the North Island of New Zealand. Wakefield described the expedition briefly[13], and McDonnell wrote two longer accounts of it—the first a report to the British Resident, Mr. James Busby[14], and the second a letter to the Secretary of the Royal Geographical Society, London. By kind permission of the Royal Geographical Society, the second report is given below:—

16 Dorset Place,
Regents Park.
15th October, 1838.

Captain Washington, R.N.,
Secretary to The Geographical Society.
Dear Sir,

You mentioned last week that some person had laid claim to the honor of *first* discovering the Entrance into the Kaipara River, and had proceeded up one of its branches for 70 miles in a Vessel named the *Fanny*. Who the party may be that has so impudently set forth such a statement, it does not become me to enquire, but I pronounce it a gross and wilful misrepresentation of the truth.

The opening of the Kaipara River had for a number of years occupied my attention. In 1830 I despatched a European with several of the Hokianga Chiefs to Kaipara for the purpose of obtaining information, and to ascertain from the Chiefs of the Kaipara district, if canoes were procurable of sufficient size to enable me to sound the Entrance. The report was unsatisfactory, and the canoes were not to be had. In 1832 I made another effort, but want of boats, boisterous weather, and other causes operated to frustrate the attempt *by sea,* however I did not abandon my intention, and my mind was bent on prosecuting it whenever circumstances possessed me with the power.

I returned to England in the latter part of 1833—and embarked for New Zealand again in January 1835. I arrived at my Establishment at Hokianga in July of the same year, via New South Wales, where I found a small Vessel of about 25 Tons nearly built up. My mind was made up to put my original project in execution. In October I despatched a European with an intelligent Chief, named Nene, and a few natives, to Kaipara, for the purpose of bringing the Chiefs of that

11. Wakefield, E. J. *Adventure in New Zealand* . . . John Murray, London. 2 vols. 1845. Vol. 1, p. 153.
12. Journal of Rev. Richard Taylor, 22 February 1841. Typescript copy in the Library of the Auckland Institute and Museum.
13. Wakefield, E. J., ibid. p. 155.
14. Thos. McDonnell R.N., A.B.R., to James Busby Esq., British Resident, 16 February 1836, with copies of letters dated 11 January 1836, from McDonnell to Titore and Taria. Originals in the Mitchell Library, Sydney, Dixson Library, Add 93; photocopies in the Library of the Auckland Institute and Museum.

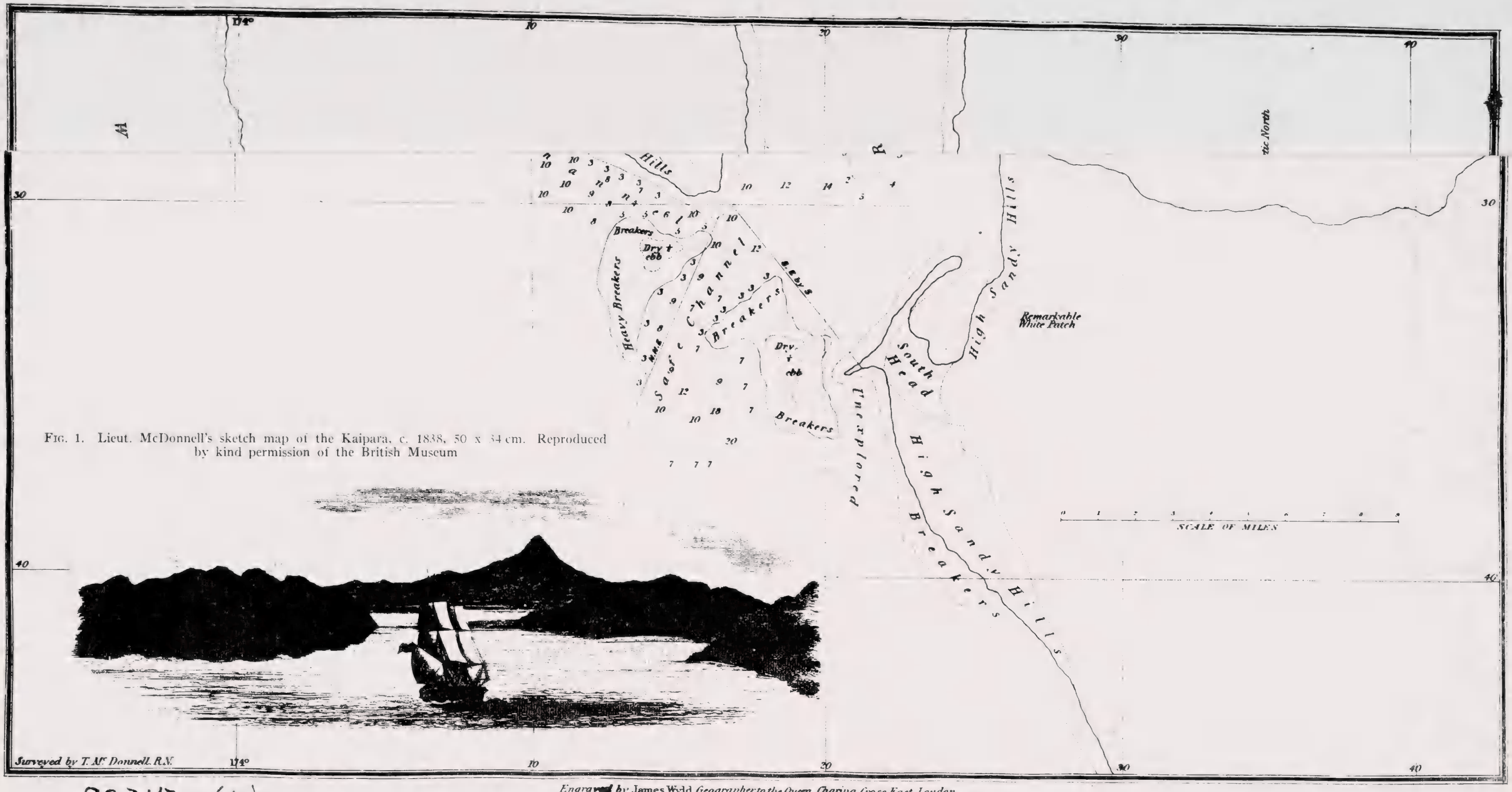

FIG. 1. Lieut. McDonnell's sketch map of the Kaipara, c. 1838, 50 x 34 cm. Reproduced by kind permission of the British Museum

92715 (1)

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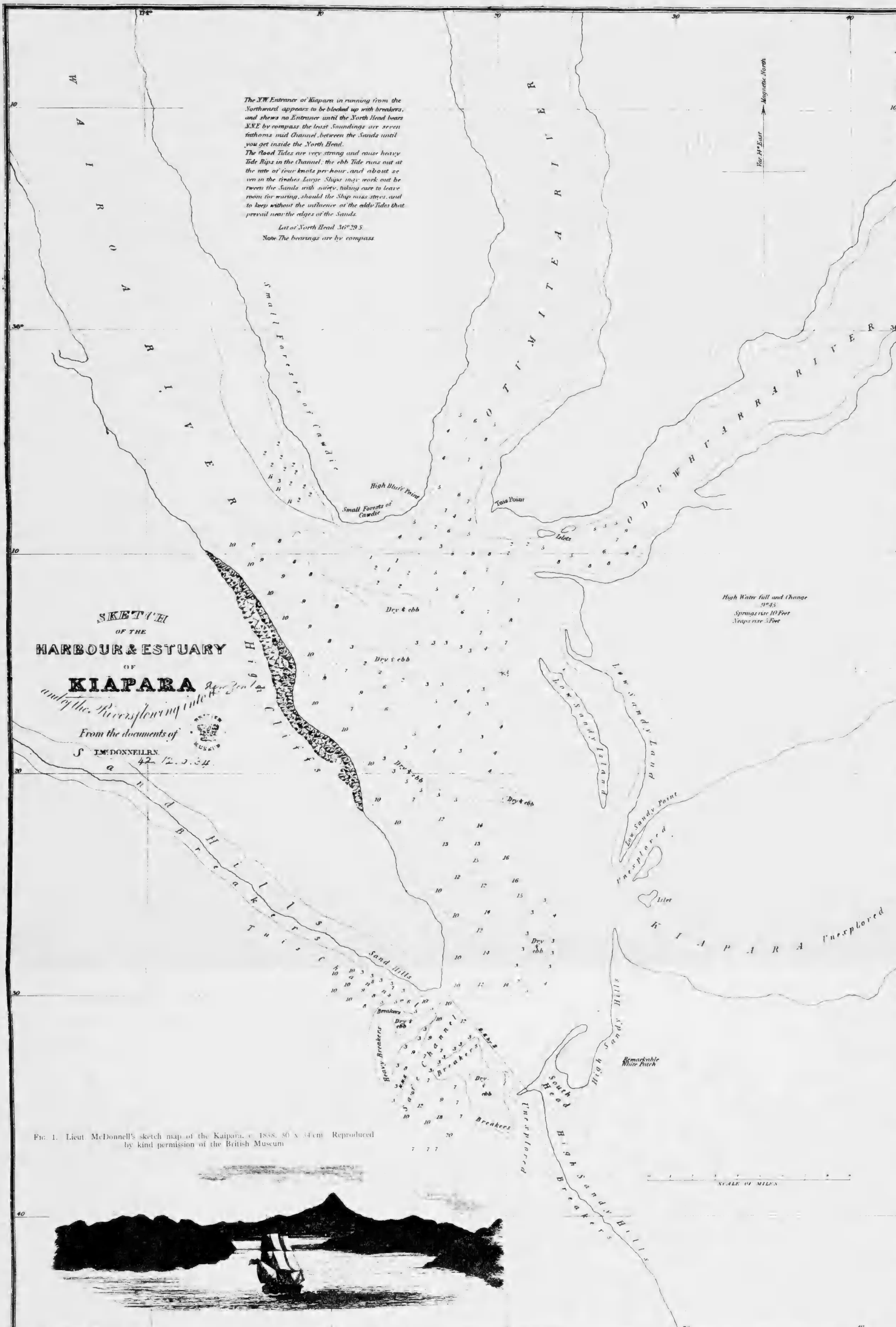

FIG. 1. Lieut. McDonnell's sketch map of the Kaipara, c. 1838. 50 x 34 cm. Reproduced by kind permission of the British Museum

district to me. On their arrival at Hokianga, I made known to them my intention of proceeding by sea in the hope of being able to discover a safe channel for Ships into the Kaipara. They were much elated at this information, our arrangements were satisfactory. The Schooner was at that time completed and was launched *in their presence* and named the *Tui* (a beautiful bird of New Zealand).

Kaipara being a conquered District lying under a "Taboo" by the Napuhae Tribes, a treaty with their Chiefs was indispensable before I ventured on my contemplated expedition. I started in November 1835 to the Bay of Islands, where I convened a meeting of the Napuhae Chiefs, Tetore at their head. Our conference was satisfactory and my wishes were gratified to their fullest extent—a Deed was executed on the 12th of the same month granting me a large tract of Country, with the removal of the Taboo, provided my Vessel was the first to cast her anchor in the Kaipara, and to fly the British flag over its waters.

I returned to Hokianga and the *Tui* started for her destination on or about the 20th of November and entered (by the inner channel) the Kaipara River on the 23rd. About the middle of December following, the *Tui* then at anchor some 70 or 80 miles up the Wairoa (a branch of the Kaipara) the *Fanny* made her appearance; commanded by a Mr. Wing. The Rev. Wm. White (since expelled his Society) was a passenger in her. It may be mentioned that the *Fanny's* original destination *was Waicato,* but the information of the *Tui* being actually in the Wairoa river induced Mr. White the Charterer of the *Fanny* to alter her Voyage, and the latter Vessel was at Anchor in the *Hokianga River* when the *Tui* was at Anchor *up the Wairoa.*

This, my dear Sir, is the correct history of the matter, and I possess unequivocal proof in corroberation of the facts. There are besides parties now in London, one of whom landed at Falmouth about a fortnight ago, from a French Whaler, who I can produce, if further proof be required. I can very accurately trace the source from whence your information is derived. It is as false as I know it to be polluted.

I remain, Dear Sir,
Yours very truly,
THOS. McDONNELL.

P.S.

Previously to my leaving England in 1834, when I had the honor last of dining at the Raleigh Club, I then expressed my determination to explore the Kaipara, and, if practicable, to set the question at rest, as to whether there was, or was not a safe channel for shipping—even the Natives of the country were ignorant on this head.—T. McD.

The Editor of the Journal of the Royal Geographical Society acknowledged that the first vessel to enter the Kaipara was the *Tui,* and that Mr. McDonnell had obligingly communicated to the Society a plan of the harbour.[15] The plan cannot be found and, probably, was returned to McDonnell. The British Museum has a printed map, pressmark 92715(1), prepared "from the documents of T. McDonnell, R.N.", showing the Kaipara Entrance and Harbour about latitude 36°S. This is reproduced as Fig. 1, by kind permission of the British Museum, London.

Presumably, Edgerley accompanied McDonnell on the expedition, as one of his plant collections, now in the Herbarium of the Royal Botanic Gardens, Kew, bore the following label:

"This beautiful dwarf shrub I have only found upon hills of great elevation, growing in sandy peat soil, about 20 miles from the sea coast, south latitude about 36°, flowers none,

15. *Jl R. geogr. Soc. Lond.* 8: 416, 1838. See, however, Stallworthy, J. in *Early northern Wairoa . . .* Wairoa Bell and Northern Advertiser . . . Dargaville, 205 pp. 1916, p. 32, where it is stated that Captain Dacre took two vessels into the Kaipara Harbour in 1832 and "was the first man to cross the bar."

seeds in panicles, capsules 6 valved, 3 exterior and 3 interior ones, generally one seeded, rarely two, ripe seed January, native, numero 32."

FIG. 2. Edgerley's Pomaderris, *Pomaderris prunifolia* Fenzl var. *edgerleyi* (Hook.f.) L. B. Moore, growing in scrub near latitude 36°S. Taharoa Lake, 15 October, 1968.

The "beautiful dwarf shrub" is now known as *Pomaderris prunifolia* Fenzl var. *edgerleyi* (Hook.f.) L. B. Moore (Fig. 2). It is a member of the Rhamnaceae, and a relative of the kumarahou. It still occurs about latitude 36°S, in a narrow strip of land between the West Coast and the Wairoa River. Here, it grows in stunted *Leptospermum* scrub, on old consolidated sandhills, eroded on the ridges and with peat swamps in the hollows (Fig. 3). It is now rare as large areas of the scrub community have been cleared for farming (Fig. 4). The narrow strip where the plant is found lies only a mile or two inland from the sea coast, and it is possible that the 20 miles (32 km) mentioned by Edgerley was an estimate of the distance up river from Kaipara Entrance.

Unfortunately, the year of collection is not recorded on the label of the specimen at Kew, but the expedition was at the Kaipara during January.[16]

16. Mrs. Ruth Ross has kindly drawn my attention to the fact that McDonnell was not at the Kaipara continuously from November 1835 to January 1836. The schooner *Industry*, owned and commanded by Mr. Sibson Bragg, sailed from George Port, Launceston, Tasmania, on 13 November 1835, bound for Hokianga. On 24 November members of the crew threw Bragg overboard. McDonnell seized the vessel at Hokianga, held the murderers and witnesses, and sent them to Hobart Town for trial. During December 1835 John Edgerley helped to guard the prisoners at Hokianga.
(Thos. McDonnell, Additional British Resident, Te Horeke, to Col. Arthur, Lt. Governor, Van Diemen's Land, 14 December 1835. Original in the Tasmanian State Archives, microfilm copy in the Alexander Turnbull Library, Wellington.)

FIG. 3. View towards the Wairoa River from the junction of the Babylon Coast Road and Baylys Basin Road, showing the stunted scrub in which Edgerley's Pomaderris is found. *Pinus radiata* is invading the scrub.

FIG. 4. Much of the country about latitude 36°S has been cleared of scrub for farming. View towards the Wairoa River from the Mt. Wesley Coast Road near Mahuta.

There is no record of Edgerley's travels in New Zealand, and the following list of localities he visited has been compiled from botanical descriptions of newly discovered plants:

Northern extremity of the Northern Island, Edgerley—*Hypolepis distans* Hook., Dennstaedtiaceae, a fern.[17]

Near Hokianga; Edgerley, in forests—*Thuja doniana* Hook., Cupressaceae, kawaka, a conifer.[18]

Bay of Islands and Wairanaka Valley, Colenso, Edgerley — *Sarcochilus adversus* Hook.f., Orchidaceae, an epiphytic orchid.[19]

Bay of Islands, Edgerley, Colenso, etc.—*Pterostylis trullifolia* Hook.f., Orchidaceae, a hooded orchid.[20]

Bay of Islands and east coast, Edgerley, Colenso, etc.—*Metrosideros colensoi* Hook.f., Myrtaceae, a climbing rata.[21]

East Coast?, Edgerley—*Pittosporum reflexum* R. Cunn., Pittosporaceae, a small shrub.[22]

Northern Island: mountainous parts of the interior, Edgerley, Colenso—*Panax edgerleyi* Hook.f., Araliaceae, raukawa, an aromatic tree.[23]

Mr. P. S. Green kindly checked the folders for several of these species in the Herbarium of the Royal Botanic Gardens, Kew, but found no Edgerley collection of *Hypolepis distans* or *Pterostylis trullifolia*. For *Metrosideros colensoi* there is a specimen labelled only "New Zealand, Edgerley". For *Pseudopanax edgerleyi* there is a specimen with a label in Edgerley's hand reading: "This is an intermediate growing tree the leaves of which are very fragrant—they aborigins tigh [sic] them about their persons for the purpose of enjoying the direct [?] odour—whence its name Rau Rau-a".

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17. Hooker, W. J. *Species filicum* . . . Vol. 2, p. 70, 1858. (Hooker, J. D. *Handbook of the New Zealand flora* . . . 2v. Reeve & Co., London. 1864-67. Vol. 2, p. 748, 1867, recorded that Colenso had advised that Edgerley was never at Cape Maria Van Diemen, but collected this plant at Hokianga.)

18. Hooker, W. J. On a new species of *Thuja* and on *Podocarpus totara* of New Zealand. *Lond. J. Bot.* 1: 571, 1842. *Thuja doniana* Hook. is now known as *Libocedrus plumosa* (D.Don)Sargent.

19. Hooker, J. D. *Handbook of the New Zealand flora* . . . Vol. 1, p. 263, 1864. The Wairanaka Valley is probably the Whirinaki Valley, near Rawene, Hokianga County.

20. Hooker, J. D. *Flora novae-zelandiae* 2v. Lovell Reeve, London. 1853-55. (*The botany of the Antarctic voyage of H.M. discovery ships Erebus and Terror, in the years 1839-1843* . . . pt II). Vol. 1, p. 249, 1853.

21. Hooker, J. D. *Flora novae-zelandiae* . . . Vol. 1, p. 68, 1853.

22. Hooker, J. D. *Handbook of the New Zealand flora* . . . Vol. 1, p. 20, 1864. This species is found only about Whangaroa and the Bay of Islands, and "East Coast" must refer to North Auckland.

23. Hooker, J. D. *Flora novae-zelandiae* . . . Vol. 1, p. 94, 1853. *Panax edgerleyi* is now known as *Pseudopanax edgerleyi* (Hook.f.) C. Koch.

Edgerley sent live plants and dried specimens to A. B. Lambert, Esq., of London. Aylmer Bourke Lambert F.R.S. (1761-1842) was a friend of Sir Joseph Banks P.R.S. (1743-1820). He served as a Councillor of the Royal Horticultural Society, and as a foundation member (and Vice-President for 46 years) of the Linnaean Society. He formed a private herbarium of some 30,000 plants by purchase of other herbaria and collections of botanical explorers[24], and was the author of a magnificent work on the Coniferae superbly illustrated by Ferdinand Bauer.[25]

Before McDonnell left England in 1834, he wrote to Lambert[26], expressing thanks for an introduction to Lord Stanley. McDonnell promised to send New Zealand plants to Lambert, and asked in return that he "remember the chap who sent them".

From time to time, Edgerley has been described as a collector for Kew.[27] In response to an enquiry, the Director, Royal Botanic Gardens, Kew, advised:—[28]

> "We have very little information about him [John Edgerley] but it seems likely that he was not sent out to New Zealand by Kew in the 1830s because this was the time when Kew's future was in the balance, and very little botanical activity took place. Unfortunately, we have no official records for this period when Kew was still the private property of the Crown."

In a recent account of Kew, Turrill remarked:—[29]

> "George III and Sir Joseph Banks both died in 1820 and Kew passed into a period of decline . . . No more collectors were sent out from Kew, though seeds and plants were occasionally received from overseas."

It is possible, however, that Lambert continued Banks' work for Kew on a minor scale. In an earlier history, Thiselton-Dyer mentioned[30] that, for some years, Lambert seemed to have succeeded to the role of Banks in the affairs of Kew.

The following letters from Edgerley to Lambert are reproduced by courtesy of the Director, Royal Botanic Gardens, Kew:

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24. *The Dictionary of National Biography . . .* 22v. University Press, Oxford. Vol. 11, p. 447, 1959-60.
25. Renkema, H. W. & J. Ardagh. Aylmer Bourke Lambert and his 'Description of the Genus *Pinus*'. *Jl Linn. Soc. Bot.* 48: 439-466, 1930.
26. Thos. McDonnell to A. B. Lambert, 7 July 1834. Original in the Bodleian Library, Oxford, Pigott ms d9; copy kindly supplied by Mrs. H. S. Miller.
27. *Auckland Weekly News* 15 June 1895 (obituary of Mrs. Sarah Edgerley); *New Zealand Herald* 9 January 1928 (visit of Dr. A. W. Hill); ibid. 30 March 1942 (obituary of Mr. W. Edgerley).
28. The Director, Royal Botanic Gardens, Kew, to the Auckland Institute and Museum, 21 March 1967.
29. Turrill, W. B. *The Royal Botanic Gardens, Kew: past and present.* Herbert Jenkins, London. 256 pp. 1959. p. 25.
30. Thiselton-Dyer, W. T. Historical account of Kew to 1841. *Kew Bull.* 1891, p. 326.

Ti, Horeke, Hokianga,
New Zealand.
March 14th 1839.

A. B. Lambert Esq.,
Lower Grosvenor Street,
London.

Sir,

The Gentleman who will deliver this Ltr is Doctor Day[31], the Physician of the Ship *Coromandel,* who has been kind enough to take charge of your case of specimens. He is a very intelligent man and fond of Naturalism, and as been very zealous in Botanical researches in N.Z. and no doubt he as a good collection of plants. You may probably derive some interesting information from him respecting the present state of this country.

I have the Honour to be Sir
Your obedient servant
JOHN EDGERLEY

Ti, Horeke, Hokianga
March 15th 1839

A. B. Lambert Esq.,
No 26 Grosvenor Street,
Grosvenor Square,
London.

Sir,

I avail myself of the earliest opportunity in sending you the few specimens I have and am happy to say I have procured the major part of the plants written for by you. I have discovered four species of the Genus Metrosideros with crimson flowers which I shall send you by this conveyance, with a large specimen of the *Cowdie* tree, also good specimens of the fruit in spirits in various stages of development with leaves and stem. You will also find two other bottles in the box with Insects and fish in them which may perhaps be interesting. You express'd a wish in your last communication not to send any more Ferns, but as I have discovered a very Handsome one I think worthy of your attention, I beg leave to introduce it to your notice. I have no intimation from you to announce the arrival of the case of living plants which I sent to you by the Ship *Earl Derham*. I am anxious to know in what state they arrived.

It is my intention not to remain in N.Z. longer than the return of Capt McDonnell unless I can turn my attention more particularly to Botanical researches.

I have the Honour to remain, Sir,
Your very Humble Servt
JNO EDGERLEY

Bagnall and Petersen[32], in a fascinating biography of William Colenso, published a letter, dated 1 March, 1839, from Colenso to Cunningham[33] regarding Edgerley and Day. Part of the letter read:—

> "Do you know by hearsay, a Mr. Edgerley, living on the banks of the Hokianga? I understand he is employed by some Noble or Gentleman in England to dry and forward plants. A Dr. Day (of the *Coromandel*) who pd. me a visit the other day, said, that

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31. Dr. R. Day (1805-1879) rendered medical service in the Hokianga and acted as tutor to the family of Rev. J. Hobbs of Mangungu, near Horeke.
32. Bagnall, A. G. & G. C. Petersen *William Colenso* . . . Reed, Wellington. 494 pp. 1948. p. 75.
33. Allan Cunningham (1791-1839) was appointed a collector for the Royal Gardens, Kew, in 1814 on the recommendation of Sir Joseph Banks. He collected in Brazil, Australia and New Zealand. He visited New Zealand in 1826 and 1838.

> Edgerley had the ferns I have and others also and that he (E.) had found Gleichenia flabellata ½-way up Maunga Taniwa (Mt. Camel) nr. Kaitaia Station.[34] I intend paying this gent: a visit, a la Paul Pry. Day had also a quantity for Engd. I hope you will be so alert as not to be robbed of your lawful honors by any 'herb-gatherer', no not even by the writer—I wd. not give Day anything fearing what might ensue . . ."

Cunningham replied to Colenso on 11 April, 1839.[35] He disclaimed knowledge of Edgerley and Day, but reported that a gardener and herb-gatherer had left England some years before with Lieut. McDonnell to dry plants for a Lord Mountnorry[36], but Cunningham did not know "even the calibre of his botanic mind."

In 1839, McDonnell visited England to offer his properties to the New Zealand Land Company. The following extracts are from the McDonnell letters preserved at Kew, and I am indebted to Mr. P. S. Green for searching the correspondence:

Thomas McDonnell (from London) to Mr. Smith[37], Kew, 19 September, 1840. About to leave for New Zealand and asking for a case of plants to take.

> "My friend Mr. Lambert will tell you of my Gardener and Botanist as a young man of good *practical* knowledge, and was known to our lamented friend Allan Cunningham[38]; on his judgement faith may be placed, he has already sent a few valuable New Zealand plants to the Duke of Bedford.[39]

McDonnell (from London) to Mr. Smith, Kew, 31 October, 1840. About to sail for New Zealand.

> "The Boxes of plants and seeds have safely arrived of which I have apprised Mr. Aiton[40], and I have suggested an arrangement by which Mr. Edgerley's services might be made available to enrich your Gardens at Kew. If through the instrumentality of Mr. Aiton Edgerley could have the appointment of Botanical collector with a small salary, of say £100 a year, his services would be exclusively devoted to the employment adverted to.
>
> I know Edgerley's worth; as a *practical* botanist he is invaluable and I have no hesitation in saying that his labours would far surpass those who pretend to greater knowledge in that beautiful study."

McDonnell (from Hokianga) to Mr. W. T. Aiton, Kew, 16 November, 1841.

> "I have much pleasure in returning your two boxes filled with New Zealand produce, the nature of which I leave Mr. Edgerley my late Botanist & Gardener to explain and I hope they will meet your approbation . . .

---

34. There is some confusion here as Mt. Camel is 20 miles (32 km) north of Kaitaia and Maunga Taniwha is about 16 miles (25.7 km) south-east of Kaitaia. There is no specimen of *Gleichenia flabellata,* collected by Edgerley, in the Herbarium at Kew.
35. Bagnall, A. G. & G. C. Petersen, ibid. p. 75.
36. The Lord Mountnorry mentioned is probably George Annesley F.R.S., Viscount Valencia, afterwards 2nd Earl of Mountnorris (1770-1844). He was a friend of Sir Joseph Banks and Mr. A. B. Lambert. One of his seats, Arley Hall, then in Staffordshire, was the English address of John Edgerley.
37. John Smith (1798-1888) began employment as a gardener at the Royal Gardens, Kew, in 1822, and was Curator from 1841 to 1864.
38. See, however, Cunningham's letter to Colenso, 11 April 1839, wherein he disclaimed knowledge of Edgerley.
39. John Russell, 6th Duke of Bedford (1766-1839) had large collections of plants in cultivation at Woburn. He was a patron of botany and a friend of Sir William Hooker.
40. William Townsend Aiton (1766-1849) succeeded his father as Gardener at Kew in 1793, and retired in 1841.

Mr. Edgerley returns to England on the ship *Sir John Falstaff*—he will wait upon you, you will find him a good plain common sensed young man, he is allowed to be a good practical botanist—the late Allan Cunningham had a high opinion of his abilities in this way, and Mr. Lambert knows his worth, he is prudent, persevering and faithful, wedded to his profession and would be invaluable to any Nobleman or Gentleman who wished to enrich themselves with the fruits of his labours—I did myself the pleasure of writing to you about him previously to my leaving England respecting his being employed to collect for the Royal Gardens at Kew—I have only to repeat* that he would be found invaluable and would amply compensate in his labours for any salary that might be paid him."

[Added in another hand] *"quite true he was a good man J. Sm."

Mrs. H. S. Miller has kindly drawn my attention to a letter at Kew, from Mr. Lambert to Sir William Hooker, dated 17 August, 1840, part of which read:—

"I have no doubt but the New Zealand trees was sent by Egerly who sent me those beautiful Conifera last year."

She has commented that Lambert was an old man when he received Edgerley's specimens and his herbarium was in a state of confusion. Lambert died on 10 January, 1842, and his plant collections, which had been bequeathed to the National Herbarium at the British Museum, were sold at auction in June.[41] The plants sent to Lambert by Edgerley between 1835 and 1842 were dispersed, some finally reaching herbaria at Cambridge, Kew, Leiden and Oxford.[42]

Shortly after Lambert's death, Edgerley returned to England and, again, I am indebted to the Director, Royal Botanic Gardens, Kew, for permission to reproduce these letters:—

Cows, Isle of Wight.
April 11th, 1842.

Mr. John Smith,
Kew Gardens.

Sir,

In answer to your Letter of this morning to Capt Gordon of The Ship, *Sir John Falstaff* concerning the plants on board for the Royal Gardens, I beg leave to say that nothing respecting the Ship's destination has as yet been known. When it is I shall not fail to forward them by the first and best conveyance as no one can be more anxious concerning their safety than Myself after the trouble I have had in collecting and bringing them so many Thousand Miles. It is my intention to see them safe to their destination. I consider it would be running a great risk to forward them from this place, but if you wish it please to write me by return of Post, and your request shall be complyed with. We are expecting Capt Gordon down this afternoon from London with his orders.

I am happy to say that most of the plants are looking well.

I am Sir,
Your obt servt,
JOHN EDGERLEY

41. Hooker, W. J. *Lond. J. Bot.* 1: 394, 1842; Renkema, H. W. & J. Ardagh *Jl Linn. Soc. Bot.* 48: 439-466, 1930.

42. Lanjouw, J. & F. A. Stafleu *Index herbariorum* Part II (2), E-H. p. 177, 1957. (*Regnum vegetabile* 9).

Arley Hall,
April 27,1842.

Sir Willm Hooker

Sir,

I did not receive your letter till late this morning, on account of my having left London. I am remaining at Arley Hall for the Present, but I purpose returning to London in the course of a week, when I shall not fail to pay you a visit[43], in the meantime the specimens are at your service. You can take as many specimens as you please at the price mentioned in your letter and if you could do anything else for me I shall feel very grateful. The fruits I have in spirits I think will be of great service to you which I will open as soon as I arrive in London. I have a few good specimens at Chelsea of Dried plants which you shall have as soon as I arrive in London.

I remain
Sir William
Your obedt servt,
JOHN EDGERLEY

Upper Arley
November 19th 42

Mr. Jno Smith
Royal Gardens
Kew.

Sir,

Having now made up my mind to leave this Country for New Zealand I hasten to inform you so that you might have plenty of time to prepare the Two Boxes of Plants you so kindly offered me. I intend to leave England on the 15th January by the Ship *Mary*—and purpose being in London towards the beginning of January—when I shall do myself the pleasure of calling upon you.

I dare say I shall be enabled to get what Fruit Trees I may require from Mr. Knight so that I shall require nothing of you but some good flowering shrubs—such as Rhododendrons—Camelias—Arbutus or Strawberry Tree—Lauristine—Portugal Laurel—Common Laurel—Azalias—a Plant or Two of Lilac—Wisteria sinensis—Tree Paeonia—with a few plants of Fuchsias—Corymbiflora if you can spare it—Ribes sanguinea—Magnolia Grandiflora—etc—Deutzia scabra—Box for Hedging—with a few good Roses, white moss if you can spare it—Acuba japonica—Cedar of Lebanon—Jasminum—or any others you may think proper to give me. Boxes equal in strength and size to those I brought home would do well. It would be advisable not to close the Boxes until the last thing and if you had a few Acorns, Chestnuts, Hawthorn Berries or any other seeds that you thought would germinate, to sow them in the Boxes. I should also be very glad of a small collection of good flower seeds—with *Fir Cones.*

I am Sir
Your very obet Servt
JOHN EDGERLEY

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43. Sir William Hooker (1785-1865) was appointed first Director of the Royal Botanic Gardens and moved to Kew in 1841.

25 Collet Place
Commercial Road
Saturday Morn.

Mr. Jno Smith,

Sir,

Having just arrived in London, I find that the Ship will not be ready for Sea for the next three weeks. Consequently there will be no hurry in closing the Boxes of Plants—but in the course of next week I hope to do myself the pleasure of calling to see you and make arrangements for sending them on Board. I hope you will have the list of Plants ready that are in greatest demand, with the native names as I am better acquainted with the New Zealand names.

Please to make my services to Sir Willm Hooker

I remain Sir
Yours Truly
JOHN EDGERLEY

There is a note in another hand on this letter:—

Sir W. J. Hooker

Not having any references to the native names of the New Zealand plants I must therefore leave Sir William Hooker to give a list of some of the more remarkable plants that are not yet in the Gardens, such as the Thuya, Metrosideros tomentosa, Alseuosmia, Maire, Freycinetia, etc.

J. SMITH

The 6 box lids are now being painted and will be ready tomorrow morning.

25 Collet Place

J. Smith Esq

Dear Sir,

I duly received your two cases of plants in good order with the other Parcels from Sir Willm Hooker. We leave the Docks on Thursday next and I should feel obliged if you would favour me with the list of the plants in the Boxes as soon as possible.

Which will oblige
Dear Sir
Your obt servt
JOHN EDGERLEY

25 Collet Place
Commercial Road

Sir Willm Hooker

In acknowledging the receipt of your letter with the parcel enclosed as also the Box of Paper, and plants, I cannot but express my sincere thanks for the favour you have conferred upon me and it shall be my study to fulfil to the utmost of my powers the promises which I have made and shall with pleasure adhere as closely as possible to your instructions which I think will be of great service to me, we shall leave the London Docks on about Thursday next, I believe we Land at the Cape of Good Hope if I can be of any service to you there I shall be most happy.

I have the honour to be
Sir William
Your oblgd Humble Servt
JOHN EDGERLEY

Before he left England, John Edgerley married Sarah Newnham of Upper Arley.[44] They took passage on the *Tyne* to Hobart Town[45], where the ship stayed to replenish. Edgerley, being afraid of missing the season, paid a fresh passage on a schooner to Auckland[46], where his arrival was recorded[47] as follows:

> "The schooner *Sisters* left Hobart Town on Tuesday evening, the 18th July with a full general cargo. Among the passengers were Mr. and Mrs. Edgerley . . . Mr. Edgerley has brought out from England a large assortment of Plants, some of which he refused great prices for in Hobart Town. Mr. Edgerley formerly resided in New Zealand and before imported a considerable number of useful trees into the country; he also took a collection of New Zealand plants to England; as a Botanist he will be a useful settler to us."

Edgerley bought 6 acres 2 roods (2.5 ha) at Newmarket in 1843 for £26/10/- and a further 5 acres (2 ha) in 1848 for £15/15/-.[48] He served as a judge at the first Agricultural and Horticultural Show[49], held on 18 December, 1843, at Mr. Hart's Exchange Hotel, Auckland (floral, horticultural and farm produce), and at the Government Domain (cattle, horses and sheep). He was befriended by Sir George Grey, Dr. Purchas, Mr. Geo Graham, and other keen gardeners of the 1840s[50] and, from 1846, he advertised fruit trees for sale, usually in May or June each year.[51]

Dr. John Johnson, Colonial Surgeon, described a nursery at Newmarket in 1846[52] and, probably, this was the Edgerley nursery:—

> "A great and pleasing change had taken place in the features of the country on either side of the road leading to the Manakou, during an absence of two years from the colony . . . A nursery garden prettily situated at the base of the lava spurs jutting out from Mount Eden was another improvement; it was filled with every variety of fruit tree in a thriving condition, and which, from being raised in the country, are more suited to the climate than those brought from Australia or Van Diemen's Land . . ."

John Edgerley died suddenly on 9 June, 1849, at the age of 35 years[53], leaving his widow with a young family. The fruit trees were sold about 1852 and the land used for cows. Mrs. Sarah Edgerley died on 5 June, 1895, aged 83 years.[54] Edgerley Avenue, Epsom, marks the site of the property.

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44. Registry of Births, Deaths and Marriages, Justice Department, Auckland; *Auckland Weekly News* 15 June 1895.
45. *Southern Cross* 12 August 1843; personal communication from Mr. J. H. Edgerley, Warkworth, March 1967.
46. Personal communication from Mr. J. H. Edgerley.
47. *Southern Cross* 12 August 1843.
48. *Auckland Historical Society Journal* 2: 25, 1963; *New Zealand Journal* 8: 223c, 1848.
49. *Southern Cross* 23 December 1843.
50. Personal communication from Mr. J. H. Edgerley.
51. e.g. *New Zealander* 30 May 1846.
52. *New Zealander* 22 September 1849.
53. Registry of Births, Deaths and Marriages, Justice Department, Auckland.
54. *Auckland Weekly News* 15 June 1895.

The live plants that Edgerley sent to England have long been forgotten. Most of the dried specimens that he prepared between 1835 and 1842 were dispersed at the auction of Lambert's herbarium. The conifers were described by Lambert in his famous work on *Pinus,* and the plants that reached Kew were used by Sir William Hooker and Dr. (later Sir) Joseph Hooker.

Edgerley's work added little to the flora of New Zealand, however, as many of the plants of Hokianga had been discovered elsewhere by earlier collectors, particularly Banks and Solander, the Forsters, Dumont d'Urville and Lesson, the Cunninghams, and Colenso. Edgerley is commemorated in the scientific names of two uncommon plants, *Pomaderris prunifolia* Fenzl var. *edgerleyi* (Hook.f.) L. B. Moore and *Pseudopanax edgerleyi* (Hook.f.) C. Koch.

Acknowledgements

Many people have answered enquiries and supplied information for this paper, particularly: the Director, Royal Botanic Gardens, Kew; the Archivist, Royal Geographical Society, London; the Keeper, Map Room, British Museum, London; the Librarian, Mitchell and Dixson Libraries, Public Library of New South Wales, Sydney; the Chief Archivist, National Archives, Wellington; and the Reference Librarian, Alexander Turnbull Library, Wellington.

I am indebted also to: Mr. P. S. Green of Kew; Mrs. H. S. Miller, 23 Shadow Lane, Larchmont, N.Y.; Mr. W A. Heap of Auckland; and Miss J. H. Goulding, Associate Botanist at this Museum, for continued assistance without which the paper could not have been written.

Finally, I must thank Mr. J. H. Edgerley, 'Gladdiswood', No. 1 R.D., Warkworth, for copies of family papers and notes.

PITTOSPORUM BRACTEOLATUM ENDL. (PITTOSPORACEAE) FROM NORFOLK ISLAND

R. C. Cooper
AUCKLAND INSTITUTE AND MUSEUM

Abstract. A seedling of *Pittosporum bracteolatum* Endl. of Norfolk Island, grown at the Auckland Institute and Museum, flowered in 1967, 1968 and 1969. Fruit formed in 1968. The flowers and fruit are illustrated.

Sir Joseph Banks (1743 - 1820) arranged for the botanist Robert Brown and the botanical artist Ferdinand Bauer to accompany Lieutenant Matthew Flinders in H.M.S. *Investigator* to survey the coast of Australia. The vessel left England in 1801, and explored the land then known as New Holland during 1802 and 1803. The *Investigator* was condemned as unseaworthy at Port Jackson in 1803, and Lieutenant Flinders sailed for England to obtain another vessel. Robert Brown and Ferdinand Bauer remained in Australia for a further eighteen months, during which time Brown visited Tasmania and Bauer spent eight months on Norfolk Island (Flinders 1814; Stearn 1960, p. 34).

Among the plants collected by Bauer on Norfolk Island was a new species of *Pittosporum* described by S. L. Endlicher (1833, p. 78) as *P. bracteolatum.* Endlicher recorded that the plant was found at Mt Pitt, and flowered in September. Subsequent authors added the following information.

"This bears the absurd name of Oleander on the Island". Maiden 1903, p. 697.

"Common in the bush. Endemic." Laing 1915, p. 27.

"Fairly common. Erect tree up to 40 ft high. Carrying fruit in May. Fruit much larger than those of any New Zealand species of *Pittosporum.* In flower June. Flowers creamy-white, fragrant. Some Islanders call this 'Oleander'; others call it the 'Snow-drop tree'. (The introduced *Nerium oleander* is called the 'Mountain Rose'.) Leaves have a faintly sweet smell when crushed, similar to those of *P. eugenioides* of New Zealand. Lane-Poole gives its name as 'Oleander' and says that the wood is used for picture frames, etc." McComish 1937-8, p. 88.

From the original description of Endlicher and the specimens in the herbaria of the Royal Botanic Gardens, Kew, and the British Museum (Natural History), South Kensington, it seemed probable that the species would be suitable for cultivation in New Zealand. Efforts to obtain the plant from Norfolk Island were unsuccessful until 1961 when Mr. A. Cates brought back seeds which were raised by Mr. J. Hunter at the Plant Diseases Division of the Department of Scientific and Industrial Research at Mt Albert.

A seedling was planted in the Museum courtyard in the winter of 1963. It grew to 4 metres tall, and flowered in August 1967. No fruits formed. The tree flowered

1

FIG. 1. *Pittosporum bracteolatum* Endl., flowering branch.

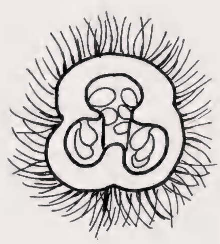
again in July 1968, and fruits ripened in May 1969. It flowered again in July 1969, but no fruits formed. It has survived fairly strong winds without damage. It is unlikely to survive heavy frosts, but should withstand salt spray. The fastigiate habit limits its value as a shade tree, but it is suitable for planting to provide shelter and privacy.

The following description has been amended from Cooper 1956, p. 123:

Trees to 12 m tall; branchlets grayish-brown, the young parts sparsely tomentulose, soon glabrate. Leaves alternate, frequently crowded at the tips of the branches, narrowly elliptic, acuminate, cuneate to attenuate at base, entire, 5 - 12 cm long, 2.0 - 3.6 cm broad, glossy green above, paler beneath, papery, sparsely pubescent when young, glabrescent, margins revolute, costa immersed above, raised beneath, secondary veins 8 - 14 per side, anastomosing, obscure above, distinct beneath; petioles 4 - 9 mm long, 1 - 2 mm broad. Flowers terminal, 1 - 8, fascicled; pedicels 1-flowered, rarely 2-flowered, 2 - 3 cm long, accrescent and recurved in fruit, usually bearing a subulate bract, subtended by a loose whorl of leaves above a cluster of caducous sparsely ciliate

2

cm



3

mm

FIG. 2. Flower, with one sepal, two petals and an anther removed; 3 transverse section of ovary.

bud scales about 1 cm long. Sepals 5, free to the base, subulate, acuminate, 10.0 - 13.5 mm long, 2.5 - 3.0 mm broad, tomentulose or glabrescent, ciliate; petals usually 5, but rarely 4 or 6 in number, linear-subulate, 1.5 - 2.0 cm long, 2.0 - 4.5 mm broad, free, recurved above the middle, yellow-green becoming cream with age; stamens 5, 7.5 - 13 mm long, anthers sagittiform, 1.5 - 3.0 mm long. Pistil at anthesis slightly shorter than the stamens; ovary 4 - 7 mm long, 1.5 - 5.0 mm

broad, tomentose; style 4.0 - 4.5 mm long; stigma obscurely capitate. Capsules globose to ovoid, usually 3-valved, but occasionally 2-valved, 2.0 - 3.5 cm long, 1.5 - 2.5 cm broad, brown-tomentose or glabrescent, rugose; valves convex to slightly sulcate in transverse section, 3 - 5 mm thick, woody, light yellow within, with a conspicuous placenta bearing two rows of short stout funicles from the base to the apex; seeds about 70, black, sticky, 3 - 4 mm in diameter.

Found only on Norfolk Island. Flowers in the winter months (June to September).

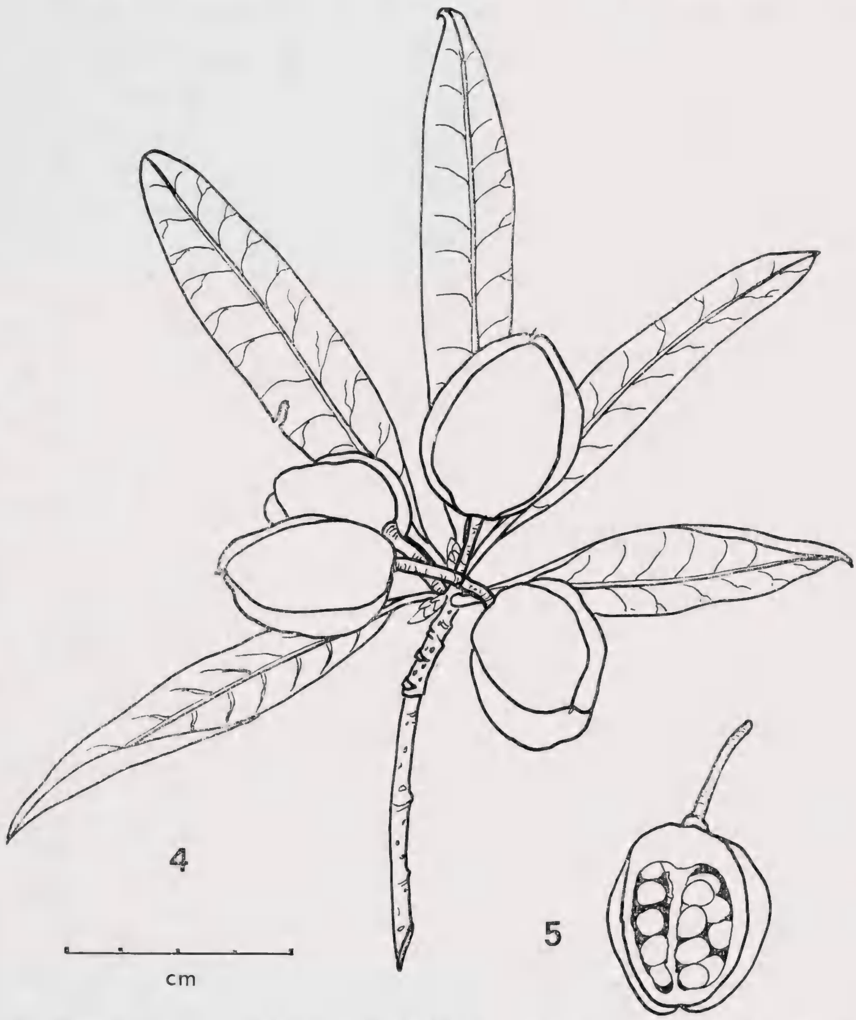


Fig. 4. *Pittosporum bracteolatum* Endl., fruiting branch; 5 fruit in longitudinal section.

Specimens examined in herbaria overseas are listed in Cooper 1956, p. 123. Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

21 (F.B. 159) Insel Norfolk, Mt Pitt, Ferd. Bauer (fr.). Ex Herb. Musei Hist. Natur. Vindob., on loan.
48881 Norfolk Island, Mt Pitt, W.R.B. Oliver, Nov 1956 (fr.green).
70473 same locality, R. S. Lediard, Oct 1960 (fr.green).
116510 Cultivated, Museum courtyard, J. H. Goulding, Aug 1967 (fl.).
118356 same locality and collector, Jul 1968 (fl.).
120520 same locality and collector, May 1969 (fr. black).

I am most grateful to Miss J. H. Goulding for drawings of the plant in the Museum courtyard, and to the Director, Naturhistorisches Museum, Vienna, for the loan of a fragment of Ferdinand Bauer's collection.

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Y

IDENTIFICATION OF PASSIONFLOWERS IN NEW ZEALAND (DICOTYLEDONES : PASSIFLORACEAE)

B. R. Young
AUCKLAND

Abstract. The species and cultivars of *Passiflora* grown in New Zealand are keyed and illustrated.

The Passifloraceae or Passionflower family, found mainly in the tropics, has 23 genera, and about 680 species of which nearly 500 belong to the genus *Passiflora* (Hutchinson 1967, p. 364). Only one member of the family belongs to the indigenous flora of New Zealand. This species has been known as *Tetrapathaea tetrandra* (DC.) Cheesem. (Fig. 1), but Hutchinson (ibid. p. 371) treats *Tetrapathaea* as a synonym of *Passiflora.*

In the following pages the *Passiflora* species and cultivars commonly grown in New Zealand are keyed and illustrated. The identification of these plants is difficult because some of the morphological characters are inconstant, and the necessary literature is not readily available.

Acknowledgements. I am indebted to the Director and staff of the Herbarium of the Royal Botanic Gardens, Kew, and particularly to Mr. Peter Green, for photocopies of Masters' 1871 and 1877 papers, other relevant descriptions and illustrations, and identifications of voucher specimens. I must also thank Dr. E. E. Chamberlain, Director, Plant Diseases Division, DSIR, Mt Albert, for allowing me the use of facilities at the station to carry out trials; Dr. R. C. Cooper, Botanist, Auckland Institute and Museum, for help in identifying and describing *Passiflora* specimens; Miss J. H. Goulding, Associate Botanist at the Museum, for drawings; Messrs. G. D. Palmer (A. W. Palmer & Sons Ltd.), D. Gay, J. Goodwin, and P. R. Beal (Redlands Horticultural Research Station, Queensland), for plants and seed; Miss J. M. Dingley, Dr. R. F. R. McNabb, Mrs. R. M. Davison, all of Plant Diseases Division, and Mr. W. A. Fletcher, Department of Agriculture, Auckland, for advice and assistance.

PASSIFLORA L.

This description has been prepared for the species commonly grown in New Zealand gardens. It does not apply to all the species of the genus, and it does not include the indigenous *P. tetrandra* Sol. ex DC. *Passiflora tetrandra* is anomalous in having unisexual, ebracteate, 4-partite flowers.

Lianes, herbaceous to woody, climbing by solitary axillary tendrils. Stems terete or angled. Stipules filiform or pinnatifid or leafy. Petioles terete or caniculate above, often with stalked or sessile glands. Flowers (Fig. 2) axillary, usually solitary, bisexual. Peduncles jointed, usually bearing an involucre of three bracts below the flower, the bracts free or partially connate. Calyx of 5 sepals,

Fig. 1. *Passiflora tetrandra* Sol. ex DC. Redrawn from Raoul 1846, pl. 27.
1a. male flowers; 1b. flowering branch with female flowers; 1c. fruit.

fused at the base and for part of their length to form a disc or cup or tube, within which there is a limen, nectar ring, operculum, corona of one or more series of filaments of tubercles, and a corolla of 5 petals alternate with the sepals. Gynophore elongated. Stamens 5, with filaments fused to the gynophore below, free above. Styles 3, stigmas capitate. Fruit ovoid or globose, varying in colour from green to yellow to orange or purple, usually with fleshy sometimes edible pulp. Seeds numerous.

2

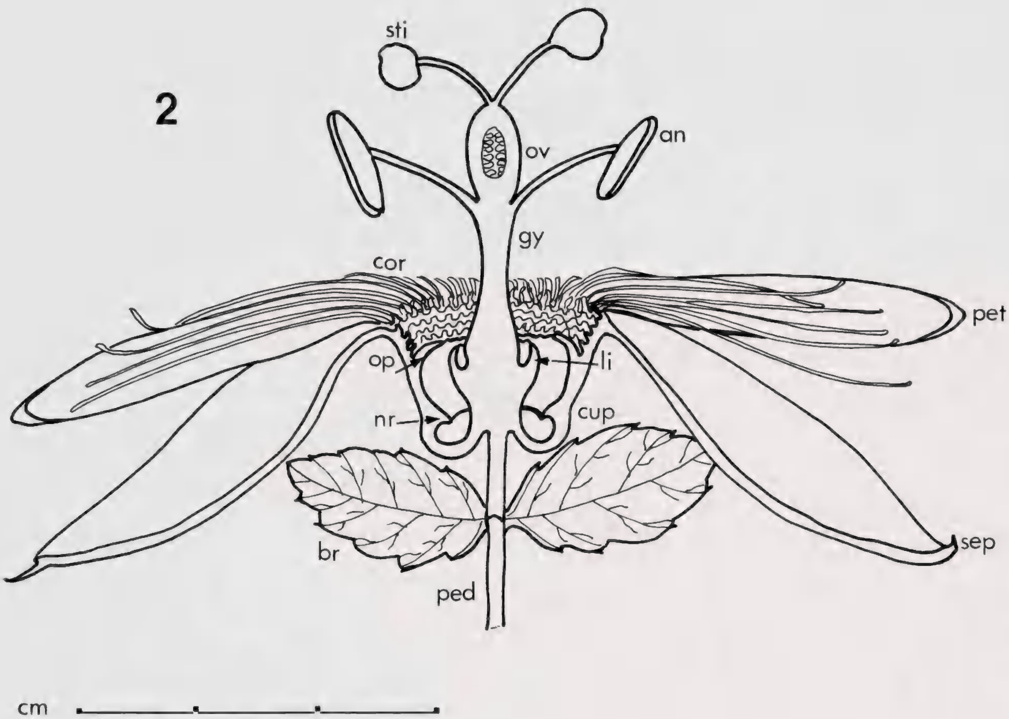

Fig. 2. Flower of *Passiflora edulis* Sims
sti stigma; **ov** ovary: **an** anther; **gy** gynophore; **li** limen; **cup** cup (or receptacle or hypanthium or calyx tube); **nr** nectar rim (or ring or annulus); **cor** corona, consisting of series of radii (or filaments) and pali (or tubercles); **op** operculum; **sep** sepal; **pet** petal; **ped** peduncle; **br** bract.

This key is designed to separate only the species and cultivars commonly grown in New Zealand gardens. Vegetative characters have been used as far as possible, but it is impossible to define some species and cultivars without reference to the flowers and fruits.

a Leaves of adult foliage entire, broadly ovate; petals white; fruit ovoid, to 8 cm long, orange brown or purplish with white specks, pulp white. 1. *P. ligularis*

aa Leaves bilobed or 3- to 9-lobed:
b Leaves bilobed; petals pink above; fruit unknown. 2. *P. sanguinolenta*

bb Leaves 3-lobed (5-lobed in *P. caerulea* and *P.* 'Eynsford Gem'):
c Petioles without glands; petals cinnabar red above; fruit subglobose, to 5.5 cm long, green, with colourless pulp. 3. *P. cinnabarina*

cc Petioles with glands*:

d Stipules filiform*:

e Stipules simple, subulate:

f Petioles glabrous, with two glands near the base of the leaf; petals white above; fruit globose or ovoid, to 5 cm long, yellow-green or purple, with yellow-orange pulp. 4. *P. edulis*

ff Petioles hirtellous*, with up to 12 glands throughout; petals cerise above; fruit fusiform, ribbed, to 12 cm long, cream-yellow, with cream pulp. 5. *P. antioquiensis*

ee Stipules pinnatifid:

g Anther filaments free from just below the ovary; leaves white lanate below; petals rose pink above; fruit subglobose, to 6 cm long, yellow, with colourless pulp. 6. *P. pinnatistipula*

gg Anther filaments free from half way up the gynophore; leaves greyish brown tomentose below; petals crimson above; fruit not seen, but said to be up to 8 cm long. 7. *P. rosea*

dd Stipules foliaceous:

h Leaves and ovaries usually pubescent; bracts partially connate, forming a tubular involucre simulating an additional calyx; calyxces tubular:

i Petioles with 8 to 12 sessile glands; leaves downy on both surfaces; bracts to 3 cm long, united for about half their length; petals rose pink above; fruit ellipsoid, 7 to 12 cm long, yellow, with yellow-orange pulp. 8. *P. mollissima*

ii Petioles with 4 to 8 stipitate or subsessile glands; leaves glabrous above, usually pubescent below; bracts to 5 cm long, united for about three-fourths of their length; petals orange above; fruit ellipsoid, to 6 cm long, yellow-green, with cream-yellow pulp. 9. *P. mixta*

hh Leaves and ovaries glabrous, leaves sometimes glaucous; bracts free; calyxces cup-shaped:

j Leaves 5-lobed (occasionally 3- or 7- or 9-lobed), lobes narrowly elliptic:

k Leaves 4 to 12 cm long; tendrils to 25 cm long; petals pink or white above; fruit ovoid, to 6 cm long, orange, with red pulp. 10. *P. caerulea*

kk Leaves to 7 cm long; tendrils to 5 mm long, often not developed; petals lilac above; fruit not formed. 11. *P.* 'Eynsford Gem'

jj Leaves 3-lobed, lobes broadly elliptic, up to 12 cm long and 14 cm wide; petals pink above; fruit not formed. 12. *P.* x *alato-caerulea*

* In studying glands, stipules and pubescence, it is necessary to use a lens. It is also desirable to study ample young material as stipules may be shed on old or dried specimens.

NOTES ON THE SPECIES AND CULTIVARS

1. **Passiflora ligularis** Juss. Figs. 3 - 5

This species is easily recognised by the entire, broadly ovate leaves, long slender petiolar glands, and the large edible fruit. The flowers are up to 10 cm in diameter, with white petals and a colourful corona of filaments striped purple, blue and white. It is a native of Central and South America.

Seed for this study was obtained from Mr. McLisky's garden at Titirangi. The species has been observed on Kawau Island, and Mr. W. Sykes (personal communi-

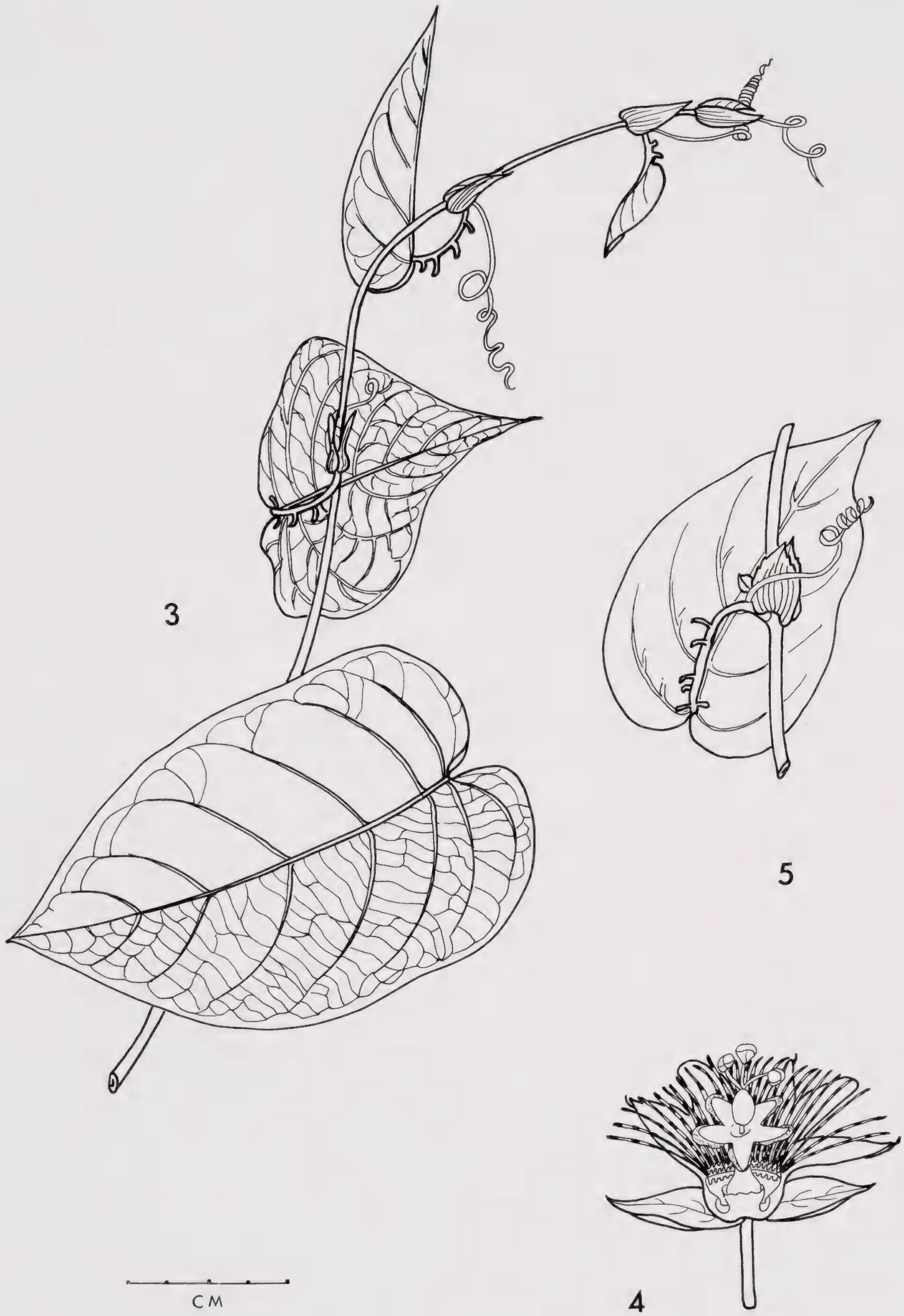

Fig. 3 Leaves of *P. ligularis* Juss.; 4 longitudinal section of a flower; 5 node with leafy stipules, tendril, and leafstalk bearing long slender glands.

cation) reports it growing at Whangarei. Mr. W. Fletcher (personal communication) reports that an old fruiting plant is growing at Kerikeri. As the species is extremely frost tender it is grown only in the warmer districts of New Zealand.

Identification has been made from the descriptions of Killip (1938, p. 344) and Standley and Williams (1961, p. 133), and the illustrations in Popenoe (1924, pl. 43) and Degener (1934, Fam. 250).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116157 McLisky's garden, Titirangi, B. R. Young, Mar 1966 (fl.).
116158 PDD, Mt Albert, B. R. Young, Mar 1966 (sterile).
116086 same locality and collector, Mar 1967 (sterile).
120483 Gladstone Road, Parnell, M. Goodey, May 1969 (fl.).

2. **Passiflora sanguinolenta** Mast. Figs. 6 - 8

This species is distinguished by the bilobed leaves. The stems are angled and hairy. The flower stalks do not bear bracts. The flowers are up to 6 cm in diameter, star-like, and pink coloured. Fruit have not developed on any of the plants observed in this study and neither Masters nor Killip described them. The species is a native of the mountains of Ecuador.

I have not found *P. sanguinolenta* in the early New Zealand nursery catalogues available to me, but D. Hay & Son, Montpellier Nurseries, Hobson Bay, Auckland, offered plants for sale in their 1924 and subsequent lists.

Material for this study was obtained from Mr. McLisky's garden at Titirangi, and from the nursery of A. W. Palmer & Sons Ltd.

Identification has been made from the following descriptions and illustrations: Masters 1868, p. 1162, and 1874, p. 226, fig. 47; Harms 1894, fig. 25c, and 1925, fig. 218c; J. D. Hooker 1900, tab. 7751; and Killip 1938, p. 253.

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116083 and 116176 PDD, Mt Albert, ex Palmer's Nursery, B. R. Young, Mar 1966 (fl.). A duplicate of 116083 sent to Kew was identified as *P. sanguinolenta* Mast.
116175 McLisky's garden, Titirangi, B. R. Young, Apr 1966 (fl.).
117559 PDD, Mt Albert, ex McLisky's, B. R. Young, Jan 1968 (fl.).
117560 PDD, Mt Albert, ex M. Goodey's garden, Judges Bay Road, Parnell, B. R. Young, Jan 1968 (fl.).

3. **Passiflora cinnabarina** Lindl. Figs. 9 - 11

This Australian species is differentiated from *P. sanguinolenta* by its palmate 3-lobed leaves and from other species in New Zealand by the scattered threadlike bracteoles on the peduncles. The star shape of the flowers, which are about 7 cm in diameter, is due to the long narrow sepals and shorter petals. The fruit are subglobose, up to 5.5 cm long, green in colour and inedible. The species is a native of New South Wales and Victoria.

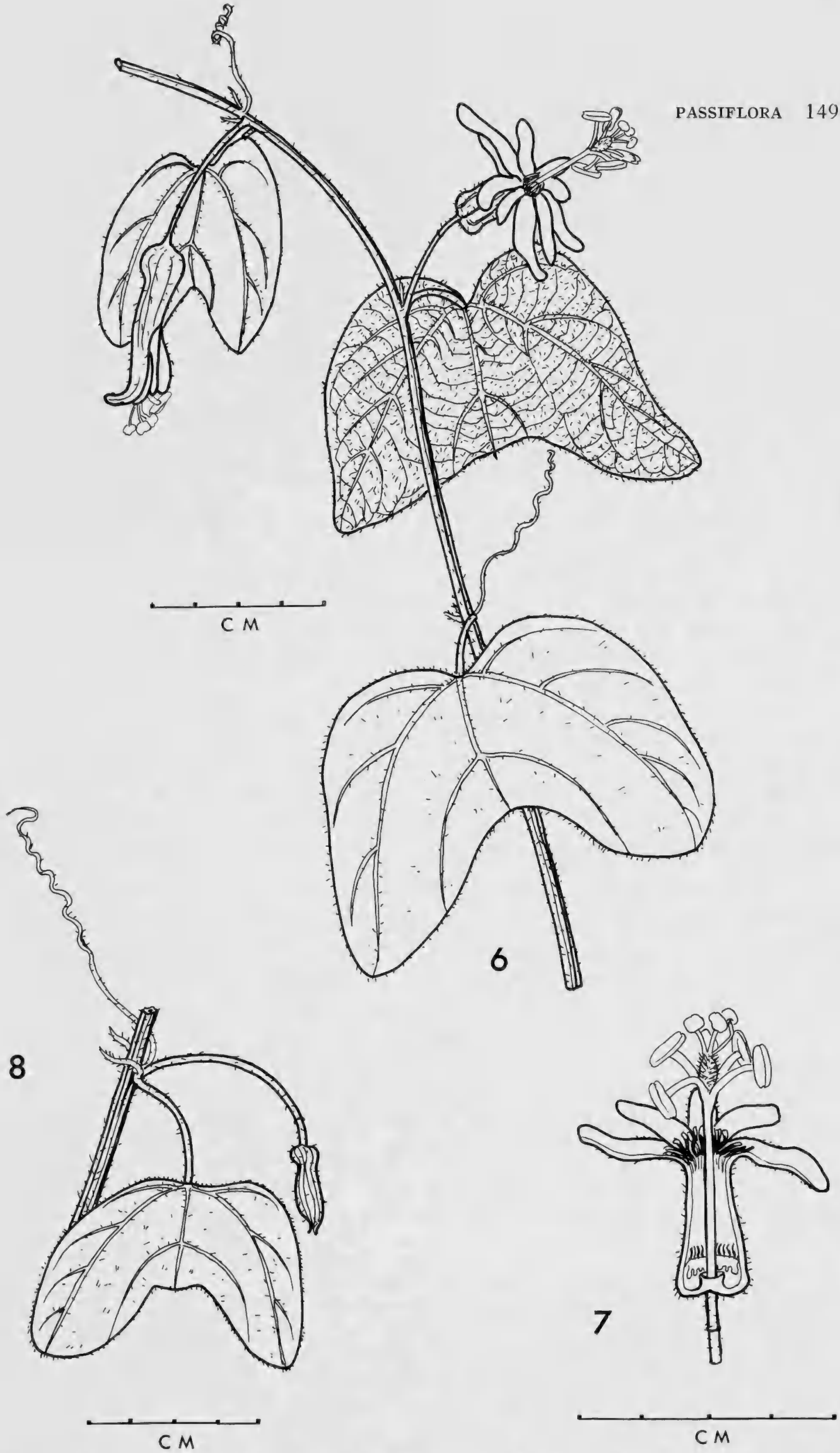

Fig. 6 Flowering branch of *P. sanguinolenta* Mast.; 7 longitudinal section of a flower; 8 node, showing the angled stem, subulate stipules, a tendril, leaf and flower bud.

Seed for this study was obtained from Australia, and seed and cuttings were collected from Parker Road, Oratia, where the species is a 'garden escape'. Mr. W. Sykes (personal communication) reports that it is growing in Wanganui and possibly in Hastings.

Identification has been made from Oliver 1871, tab. 5911.

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116082 PDD, Mt Albert, ex Australia, B. R. Young, Jan 1967 (fl.).
116177 Parker Road, Oratia, B. R. Young, Mar 1966 (sterile).
116178 PDD, Mt Albert, ex Oratia, B. R. Young, Mar 1966 (sterile).
117466 same locality and collector, Nov 1967 (fl.).
117575 same locality and collector, Dec 1967 (fl. and fr.). A duplicate of 117575 sent to Kew was identified as *P. cinnabarina* Lindl.
117964 Garden escape at Parker Road, Oratia, Mrs. S. Davison, Sept 1965 (fl. and fr.).

4. **Passiflora edulis** Sims — Figs. 12 - 15

This species is distinguished by its bristle-like stipules, glabrous 3-lobed leaves, and the two glands on the petiole near the base of the leaf. The flowers are white, up to 7 cm in diameter, with wavy white corona filaments banded with purple near the base. The fruit are globose to ovoid, up to 5 cm long, green, yellow, brownish purple or dark purple, with yellow-orange edible pulp. The species is a native of Brazil.

There is considerable variation in the colour, polish and shape of the leaves, the presence of glands, the length and purpling of the corona, and the shape and colour of the fruit. Last century several authors described the variants as species, but Masters (1871, p. 637) reduced these to varieties. Killip (1938, p. 396) noted two distinct flower forms but, as they are not correlated with the differences in vegetative characters, he preferred not to assign formal names to them.

At least three varieties are grown here at present:—

Stems always green; fruit purple. — 1. *P. edulis* var. *edulis*
Stems often reddish; fruit green, yellow or greenish purple:
  Styles spotted with purple; fruit green or greenish purple. — 2. *P. edulis* var. *rubricaulis*
  Styles whitish green; fruit yellow. — 3. *P. edulis* forma *flavicarpa*

Passiflora edulis Sims var. *edulis* has been cultivated in New Zealand since 1872 or earlier (Hay 1872, p. 42). The first large commercial plantings were made at Kerikeri, Bay of Islands, in 1927 as a 'stop gap' when establishing citrus orchards. During the years 1927 to 1935, 20,000 vines (60 acres) were interplanted on trellises with citrus. As crops more than fulfilled the local demand, growers tried cool storing and shipping the fruit as well as freezing and canning the pulp. A commercial company took over the pulping factory and, in 1935, successfully marketed 4,600 gallons of pulp in the United Kingdom (Anon. 1934, p. 9). Soon, passionfruit became the main crop of a number of Kerikeri growers, and their success led others to plant orchards at Auckland and Tauranga.

At this time no disease of any consequence was present, but ten years later the yield had been reduced to about a tenth; grease spot, a bacterial disease caused by *Pseudomonas passiflorae* (Reid) Burkholder, and brown spot a fungous disease caused by *Alternaria passiflorae* Simmonds, had become common, killing a large number of plants and making the fruit unmarketable.

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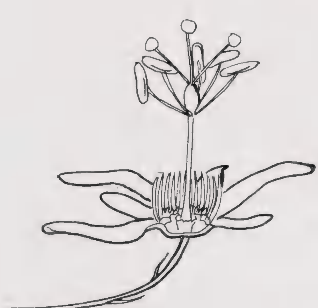

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Fig. 9 Flowering branch of *P. cinnabarina* Lindl.; 10 longitudinal section of a flower; 11 fruit.

Although these two diseases and root rot restricted passionfruit culture about Auckland, plantings in the Bay of Plenty district were relatively successful. By 1950, this district had become the main production area, and the industry expanded there until 1960 when 190 tons of fruit were produced. In recent years, however, production has declined, e.g., to 75 tons in 1964, and growers have replaced passionfruit with more disease-resistant crops. As well as grease spot, brown spot and root rot, the fungous diseases, crown canker, *Fusarium sambucinum* Fekl., and septoria blotch *Septoria passiflorae* Louw., are now of major importance, causing loss of plants and fruit each season.

In the hope of obtaining disease-resistant plants, growers have recently imported other varieties. *Passiflora edulis* Sims var. *rubricaulis* (Jacq.) Mast., obtained from Brazil by Mr. Johansen, a nurseryman of Te Atatu, is an extremely vigorous variety. In cultivation, the stems vary in colour from red to green, the coronal bandings from pale to bright purple, and the fruit from green to purplish brown. At one extreme, these characters resemble those of var. *edulis* and, at the other, they approach those of forma *flavicarpa*. This variety is much hardier than forma *flavicarpa*, however, and will tolerate frosts up to 5°F.

Pope (1935, p. 13) has recorded that a Mr. E. N. Reasoner of Florida obtained seed of a passionfruit in Australia and passed some on to the Hawaii Experiment Station in 1923. The Station submitted specimens and photographs to E. P. Killip, who identified them as a yellow-fruited form of *P. edulis* (Pope, ibid. p. 2). Later, the plants were described and named as *P. edulis* Sims forma *flavicarpa* by Degener (1932, Fam. 250). This form is frost tender and will grow only in well-sheltered positions. It does not seem to be suitable for commercial plantings in New Zealand.

Material for this study was obtained from plants grown at the Plant Diseases Division, DSIR, Mt Albert. Plants of var. *edulis* were raised from seed collected at a commercial planting near Te Puke, var. *rubricaulis* from seed given by Mr. Johansen, and forma *flavicarpa* from seed sent by the Redlands Research Station, Australia.

Identifications have been made from the following literature:—

Passiflora edulis Sims var. *edulis*: Sims 1818, tab. 1989; Masters 1872, p. 610 and tab. 122, fig. 1; Killip 1938, p. 393.

var. *rubricaulis* (Jacq.) Mast.: Jacquin 1844, tab. 169; Masters 1871, p. 637.

forma *flavicarpa* Degener: Degener 1932, Fam. 250; Pope 1935, fig. 3.

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

Passiflora edulis Sims var. *edulis*

44160 Near Meteorological station, Raoul Island, R. C. Cooper. June 1956.
114206 PDD, Mt Albert, B. R. Young, Mar 1967 (seedling).
115947 same locality and collector, May 1967 (fl.).
117875 same locality and collector, Apr 1968 (fl.). A duplicate of 117875 sent to Kew was identified as *P. edulis* Sims.

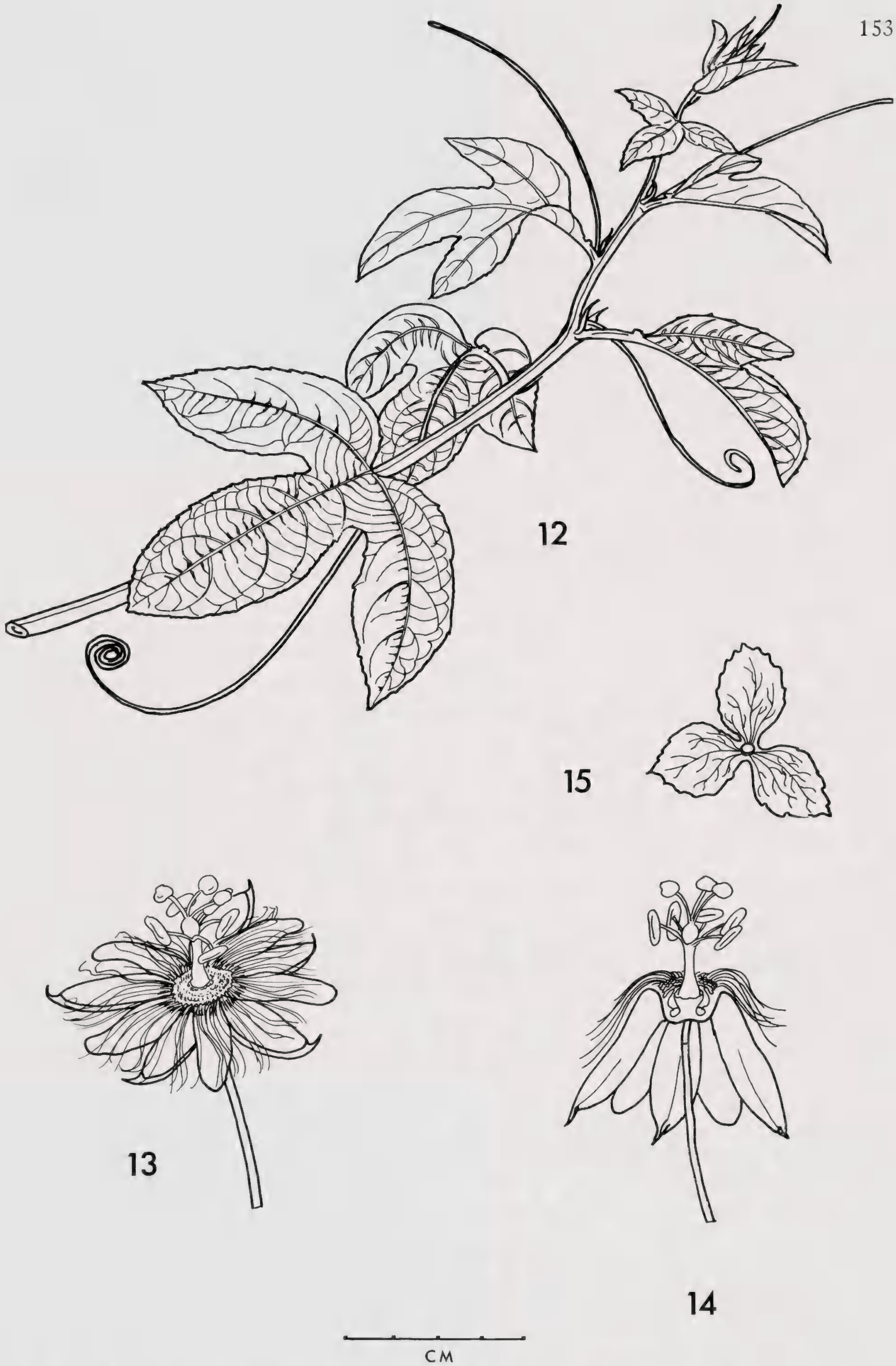

Fig. 12 Flowering branch of *Passiflora edulis* Sims var. *edulis;* 13 fully opened flower; 14 longitudinal section of a flower; 15 bracts. See also Fig. 2.

var. *rubricaulis* (Jacq.) Mast.

114199, 114207, 114210, 114211. PDD, Mt Albert, red-stemmed and green-stemmed seedlings from red-stemmed, green-fruited parent, B. R. Young, Mar 1967.
114209 PDD, Mt Albert, red-stemmed (streak of red only) seedling, B. R. Young, Mar 1967 (fr. green).
114974 PDD, Mt Albert, red-stemmed seedling, B. R. Young, 1966 (fl., fr. green and greenish purple). A duplicate of 114974 sent to Kew was identified as *P. edulis* Sims.
115712, 115713, 115951. PDD, Mt Albert, red- and green-stemmed seedlings with glands on the margins of the bracts, B. R. Young, May 1967 (fl.). Similar glands are present on 114974 and 116087; c.f. *P. verrucifera* Lindley (1840, tab. 52), which was transferred to *P. edulis* Sims as var. *verrucifera* (Lindl.) Mast. (1871, p. 637), and finally reduced to synonymy by Killip (1938, p. 393).
116087 Roberts Road, Te Atatu, parent plant of seedlings, B. R. Young, Aug 1966 (fl.).

forma *flavicarpa* Degener

30119 Mokuleio, Oahu, Hawaii, cultivated, O. & I. Degener, Sep 1965 (fl.).
114197, 114198, 114200. PDD, Mt Albert, B. R. Young, Mar 1967.

5. **Passiflora antioquiensis** Karst. Figs. 16 - 18

This species is easily distinguished from others present in New Zealand by the cerise flowers which hang on pubescent stalks up to 20 cm in length. The palmate, deeply 3-lobed leaves are covered in brownish hairs. The flowers, up to 12 cm in diameter, have a calyx tube to 6 cm in length with the corona reduced to pinkish tubercles. The creamish-yellow fruit are spindle-shaped, to 12 cm long, and markedly longitudinally ribbed. The pulp is cream in colour, with a distinctive vanilla flavour which is more pleasant than that of other banana passionfruit. In New Zealand, this species is called the vanilla or red banana passionfruit. It is a native of the mountains of Colombia.

For many years, this species was known as *Tacsonia* or *Passiflora van-volxemii,* and it was offered for sale under that name (e.g. Hay 1872, p. 43). Unfortunately it is frost tender and a shy bearer.

Material for this study was obtained from Mr. W. Fletcher's garden at Hillsborough, Auckland, and Dr. R. C. Cooper's garden at Parnell, and from specimens collected at Paihia, Bay of Islands, by Dr. R. Cumber.

Identification was made from the description in Killip (1938, p. 302) and the illustration in Masters (1877, pl. 6).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116085 524 Parnell Road, Miss J. Cooper, Jan 1967 (fl. and fr.).
116159 Hillsborough, W. A. Fletcher, Apr 1966 (fl.).
116160 Mt Albert, J. Leith, Mar 1966 (fl.). A duplicate of 116160 sent to Kew was identified as *P. antioquiensis* Karst.
116161 Paihia, Bay of Islands, R. Cumber, Mar 1966 (sterile).

6. **Passiflora pinnatistipula** Cav. Figs. 19 - 22

Of the species present in New Zealand, only two, *P. pinnatistipula* and *P. rosea,* produce pinnately branched stipules. In *P. pinnatistipula* the leaves are leathery, green and glabrous above, and white lanate beneath. The pink flowers, 10 to 12 cm in diameter, have a calyx tube up to 5 cm long and a filamentous violet blue corona.

Fig. 16 Flowering branch of *P. antioquiensis* Karst.; 17 longitudinal section of a flower; 18 fruit.

The three bracts at the base of the flower are free. Yellow subglobose fruit, up to 6 cm long, are borne sparingly on the plants observed. The species is a native of Colombia, Ecuador, Peru and Chile.

Material for this study was obtained from plants at Plant Diseases Division. DSIR, Mt Albert, grown from seed collected by Mr. C. A. Techer, Dunedin, and from a plant in Mr. Smith's garden, Massey, Auckland.

Identification has been made from the ilustrations in Paxton (1834, p. 249 and pl.) and W. J. Hooker (1844, tab. 4062), and the description of Killip (1938, p. 276).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

114201-3 PDD, Mt Albert, B. R. Young, Mar 1967 (fl.).
115180 same locality and collector, Apr 1967 (fr. yellow).
115709 same locality and collector, May 1967 (fl. and fr.). A duplicate of 115709 sent to Kew was identified as *P. pinnatistipula* Cav.
116163, 116165 Chorley Avenue, Massey, J. G. Smith, Apr 1966 (fl.).

7. **Passiflora rosea** (Karst.) Killip Figs. 23 - 28

This plant is remarkable in having the anther filaments free from half way up the gynophore instead of just below the ovary. The leaves differ from those of *P. pinnatistipula* in their softer texture, broader lobes, and the greyish brown tomentum beneath. The flowers are similar to those of *P. pinnatistipula* in the calyx tube up to 5 cm long and the deep violet corona filaments, but differ in the anther filaments and the crimson petals.

Killip (1938, p. 280) considered that *P. rosea* is a hybrid between *P. pinnatistipula* and *P. mollissima.* He observed it growing wild near Tarma, Peru, with the two reputed parents nearby. He recorded that it occurs as a cultivated plant, or wild as a natural hybrid, from Colombia to Peru. In New Zealand, it is grown occasionallly as an ornamental climber. Fruit has not been observed here, but Killip (ibid. p. 279) described them as ovoid and 8 cm long.

Plants for this study were raised at Plant Diseases Division, DSIR, Mt Albert, from cuttings collected by Mr. J. W. Goodwin at Pukekura Park, New Plymouth, where it was incorrectly known as *P. coccinea,* and from cuttings given by Wilson's Nurseries, Gisborne.

Identification has been made from Killip (1938, p. 278).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116167 Pukekura Park, New Plymouth, ex Duncan & Davies Ltd., J. W. Goodwin, Apr 1966 (sterile).
117573 PDD, Mt Albert, grown from cuttings ex Pukekura Park, B. R. Young, Oct 1967 (fl.). A duplicate of 117573 sent to Kew was identified as *P.* x *rosea* (Karst.) Killip. In the flowers of this plant the anther filaments are free from half way up the gynophore (Fig. 25).
117574 PDD, Mt Albert, grown from cuttings ex Wilson's Nurseries, Gisborne, Oct 1967 (fl.). In the flowers of this plant the anther filaments are free from above the middle of the gynophore (Fig. 26) and the petals are lighter in colour.

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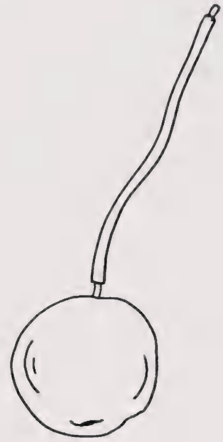

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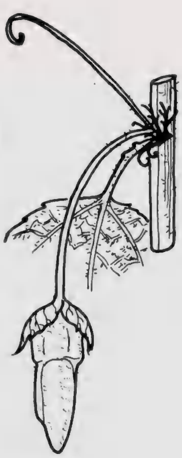

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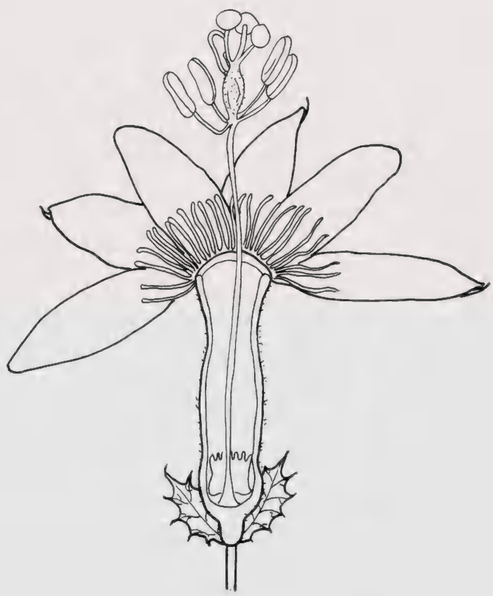

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Fig. 19 Flowering branch of *P. pinnatistipula* Cav.; 20 longitudinal section of a flower; 21 node with pinnatifid stipules, a tendril, leaf and bud; 22 fruit.

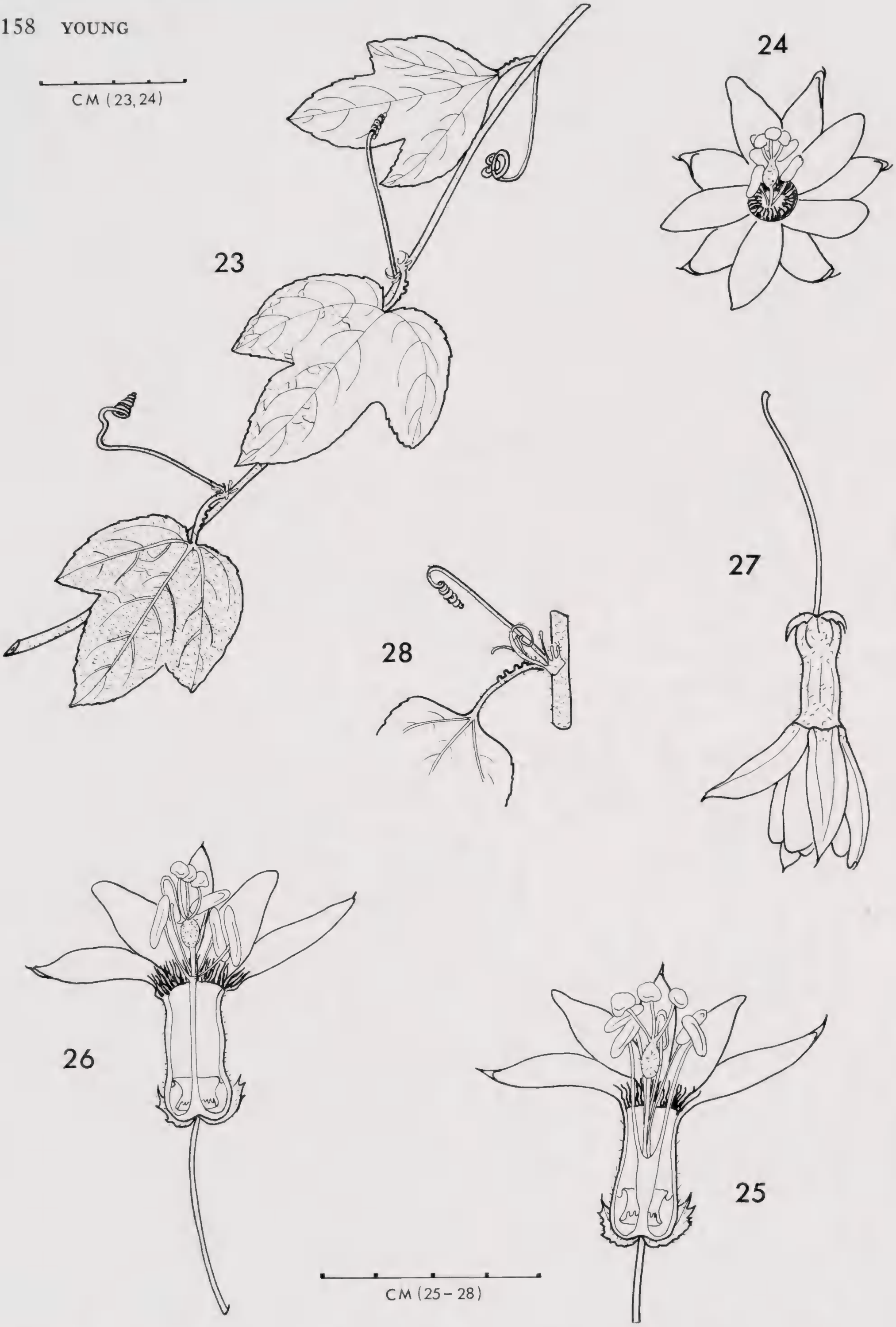


Fig. 23 Leaves of *P. rosea* (Karst.) Killip; 24 flower; 25 longitudinal section of a flower of specimen 117573; 26 l.s. of a flower of specimen 117574; 27 flower bud; 28 node with pinnatifid stipules, a tendril and leaf.

8. **Passiflora mollissima** (HBK.) L. H. Bailey Figs. 29 - 32

This species and *P. mixta* are separated without difficulty from *P. pinnatistipula* and *P. rosea* by their leafy stipules. They are distinguished from other species with foliaceous stipules (e.g. *P. caerulea*) by the presence of hairs on the leaves and ovaries, their long tubular calyxces, and the involucral bracts which simulate an additional calyx.

Passiflora mollissima is distinguished from *P. mixta* in having 8 to 12 more or less sessile glands on the petiole, leaves downy on both surfaces, and bracts up to 3 cm long, united for about half their length to form an involucre. The petals are rose pink above, and the fruit are ellipsoid, 7 to 12 cm long, yellow, with yellow-orange pulp. The species is a native of Venezuela, Colombia, Peru and Bolivia, and it is cultivated extensively in the Andes. It was offered for sale in New Zealand last century (Hay, 1872, p. 43) under its old name of *Tacsonia mollissima,* but it is found now only as a garden escape in Nelson and the West Coast of the South Island.

Material for this study was collected at Ruby Bay, Nelson, by Mr. D. Gay, and at the Pancake Rocks, Punakaiki, Westland, by the author.

Identification has been made from the descriptions and illustrations of W. J. Hooker (1845, tab. 4187), Paxton (1846, p. 25 and pl.), Popenoe (1924, p. 125, pl. 44), and Killip (1938, p. 291).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116088, 116170 Ruby Bay, Nelson, D. Gay, Mar 1966 (fl. and fr.).
116089 PDD, Mt Albert, seedling of Ruby Bay plant, B. R. Young, June 1967 (sterile).
117584 Pancake Rocks, Punakaiki, Westland, B. R. Young, Feb 1968 (fl.).
117874 PDD, Mt Albert, B. R. Young, Apr 1968 (fl. and fr.).
Duplicates of 116088 and 117874 sent to Kew were identified as *P. mollissima* (HBK.) L. H. Bailey.

Killip (1938, p. 293) mentioned that *P. mollissima* seemed to cross freely with other species. Plants collected in New Zealand that combine some of the characters of *P. mollissima, P. mixta,* and possibly *P. pinnatistipula,* are listed at the end of the section on *P. mixta*. Numbers 116084, 116173 and 116174 listed there are representative of a form that is widely grown in frost-free areas of New Zealand for its ornamental beauty and edible fruit, and that is known in the nursery trade here as *P. mollissima* or the yellow banana passionfruit. Possibly it has replaced the true *P. mollissima* in gardens because of the better quality of its fruit.

9. **Passiflora mixta** Linn.f. Figs. 33 - 35

This species is distinguished from *P. mollissima* in having 4 to 8 stipitate or subsessile glands on the petiole, leaves glabrous above and sparsely hairy beneath, and bracts up to 5 cm long, united for about three-fourths of their length. The petals are described by Killip (1938, p. 295) as pink to orange red, and are a glowing orange in our specimens. The fruit are ellipsoid, to 6 cm long, yellow green with cream-yellow pulp. The species is a native of Venezuela, Colombia, Ecuador, Peru and Bolivia.

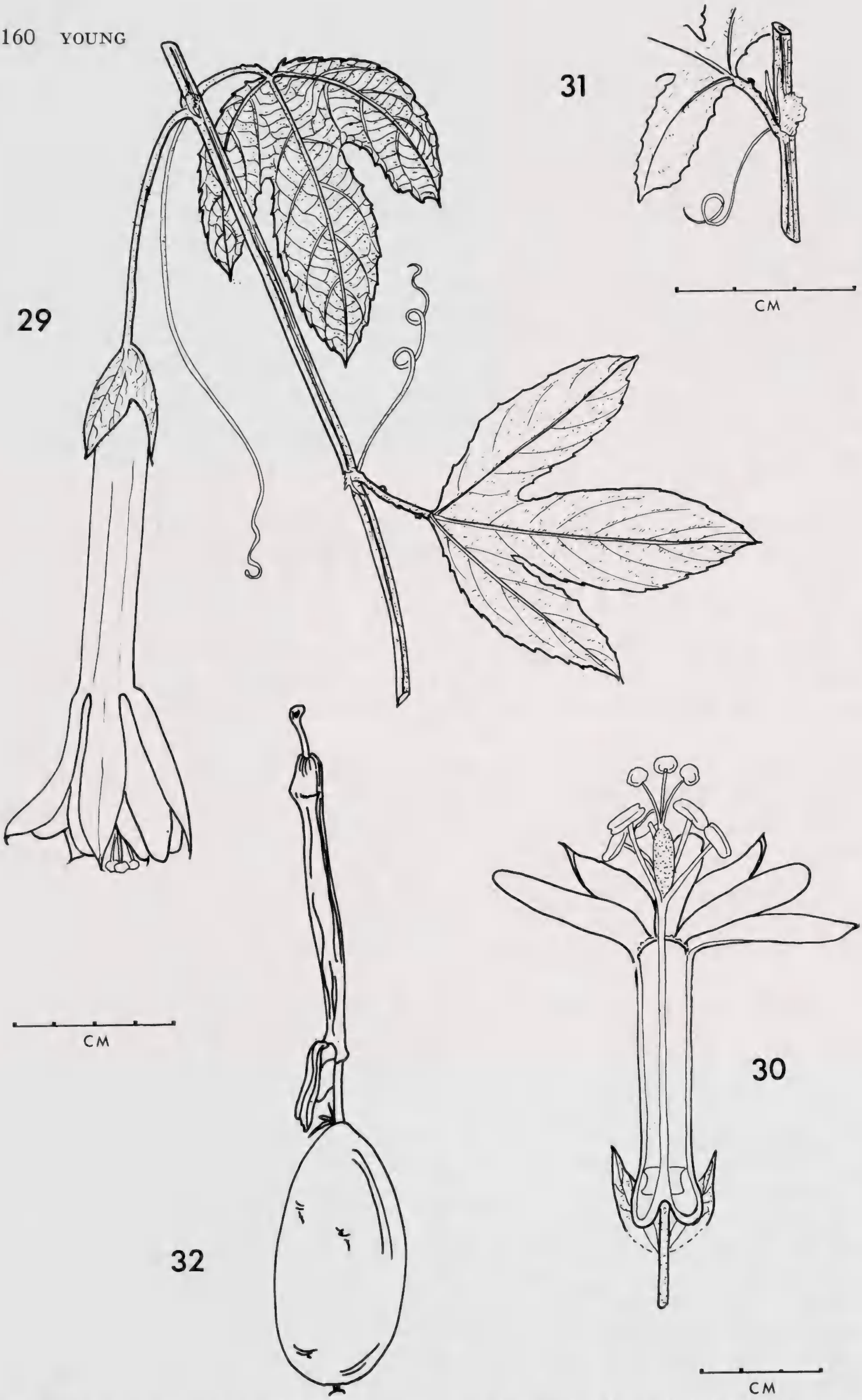


Fig. 29 Flowering branch of 116088, *P. mollissima* (HBK.) L. H. Bailey, flower not fully open; 30 fully open flower in longitudinal section; 31 node with stipules, a tendril and leaf; 32 fruit.

Seed and cuttings were collected by Dr. R. F. R. McNabb from garden escapes at Godley Road and Bishop's Reserve, Titirangi, and raised at the Plant Diseases Division, DSIR, Mt Albert.

Identification was made from the descriptions and illustrations of J. D. Hooker (1869, tab. 5750 and 1870, tab. 5876) and Killip (1938, p. 293).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116169, 116171 Godley Road, Titirangi, R. F. R. McNabb & B. R. Young, Mar 1966 (fl.).
114976 PDD, Mt Albert, seedling ex Godley Road, B. R. Young, Apr 1967 (fl.).
117563 same locality, collector and source, Jan 1968 (fl.). A duplicate of 117563 sent to Kew was identified as *P. mixta* Linn.f.

Last century, several authors described plants allied to *P. mixta* as distinct species, and Masters discussed these entities and reduced them to subspecies and varieties of *Tacsonia* (now *Passiflora*) *mixta* in a series of papers (1869, p. 388; 1870, p. 955; 1871, p. 629; 1872, p. 541 and 1877, p. 126).

In the last treatment (1877, p. 126) Masters listed three varieties cultivated in European gardens. These seem to have been distinguished:—

Tacsonia mixta Juss.

var. *speciosa* Mast.	var. *quitensis* Mast.	var. *eriantha* Mast.
Leaf lobes oblong-lanceolate, hooked-serrate; petioles with stalked glands; bracts downy, net-veined. Described originally as *Tacsonia speciosa* HBK. (1817, p. 143).	Leaf lobes ovate, serrate; petioles with sessile glands; bracts velvety, veins obscure. This variety is shown in J. D. Hooker 1870, tab. 5876.	Similar to var. *quitensis*, but more densely pubescent. Bracts conspicuously veined. This variety is shown in J. D. Hooker 1869, tab. 5750.

Killip (1938, p. 297) considered that it is impossible to recognise the species which have been segregated from *Passiflora mixta*, or to accept the subspecies and varieties proposed by Masters. Killip remarked that the characters assigned to the various taxa are inconstant and impossible to correlate, and he concluded that *P. mixta* hybridises freely in nature. He listed a number of variations in the pubescence of *P. mixta*, and published the new combination, *Passiflora mixta* var. *eriantha* (Benth.) Killip, with the diagnosis:

Stem glabrous; leaves densely white-or yellowish-lanate between the nerves and veins beneath; bracts white-lanate, at length glabrate; calyx tube grayish lanate.

Several plants collected in New Zealand cannot be fitted into *P mollissima, P. mixta*, or the various categories set out above. They are recorded in the Herbarium of the Auckland Institute and Museum:—

117562 PDD, Mt Albert, seedling of the Ruby Bay collection numbered 116088 and 116170 and identified at Kew as *P. mollissima*, B. R. Young, Jan 1968 (fl.). A duplicate of 117562 sent to Kew was identified as "*P. mixta* Linn.f. or a hybrid of this species with *P. mollissima* (HBK.) L. H. Bailey."
117558 PDD, Mt Albert, seedling from a fruit of "*P. mollissima*", B. R. Young, Jan 1968 (fl.). A duplicate of 117558 sent to Kew was identified as *P. mixta* or a hybrid. Mr. P. S. Green noted that similar material at Kew is labelled as a cross between *P. mixta* and *P. pinnatistipula*, but it is hardly intermediate between the two species.
116084 Windmill Road, Epsom, Miss J. Reid, Jan 1967 (fl. and fr.).
116173 Paihia, Bay of Islands, R. Cumber, Mar 1966 (fl.).
116174 Otahuhu, G. Young, Mar 1966 (fl.).

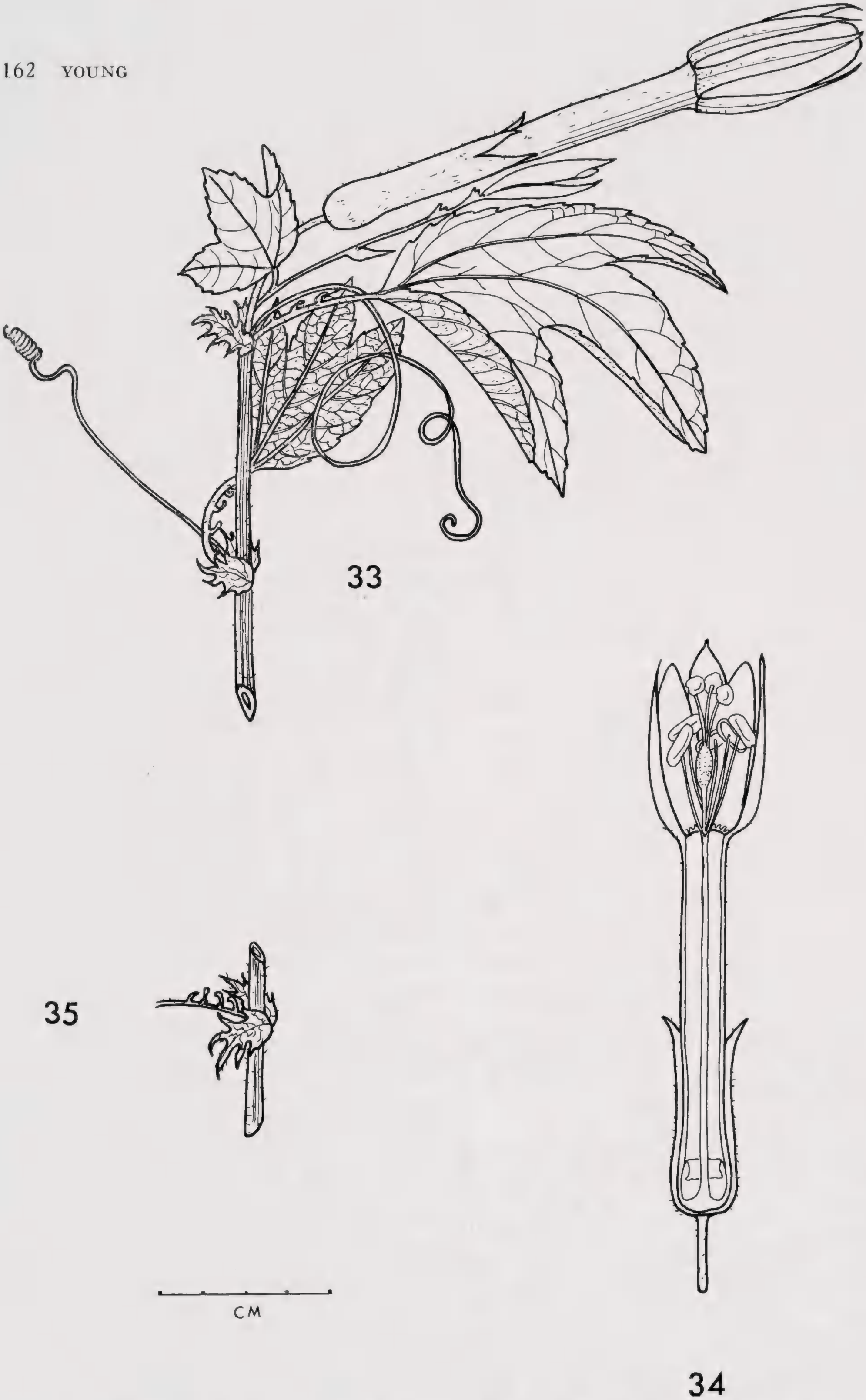


Fig. 33 Flowering branch of 114976, *P. mixta* Linn.f.; 34 longitudinal section of a flower; 35 node with leafy stipules and a leafstalk bearing stalked glands.

The Windmill Road, Paihia and Otahuhu collections resemble the seedling 117558, identified as *P. mixta* or a hybrid. All these specimens have bristle-like stipules about 4 mm long, often shed; sessile glands on the petioles; bracts up to 3.5 cm long, fused only at the base or to one-third of their length, spreading above; and calyx tubes only 6 cm long or less, markedly swollen at the base. These plants are known in the New Zealand nursery trade as *P. mollissima,* or the yellow banana passionfruit.

10. **Passiflora caerulea** L. Figs. 36 - 38

In this species, the palmate leaves are 5-lobed (occasionally 3- or 7- or 9-lobed), the lobes being narrow and often glaucous. The bracts are free. The flowers, about 6 cm in diameter, are cup-shaped, with pink or white petals. The corona filaments are purple at the base, white at the middle, and blue at the tips. The fruit are ovoid to globose, up to 6 cm long, bright orange in colour, with deep red pulp. They are inedible. The species is a native of South America, occurring from Brazil to Argentine. It is grown in Auckland, and has been observed as a garden escape at Mangawhai, Warkworth, Takapuna, Coromandel and Thames.

Passiflora caerulea 'Constance Elliott', a large pure-white form described by Masters in 1884 (p. 700), is listed in New Zealand nursery catalogues (e.g. D. Hay & Son 1891, p. 12), but I have not found it.

Plants of *P. caerulea* were raised at Plant Diseases Division, DSIR, Mt Albert, from seed collected at Mr. C. Foster's farm, Warkworth.

Identification has been made from Killip's description (1938, p. 423) and the illustrations of Curtis (1786, tab. 28) and Masters (1884, p. 701).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

113918 Arran Street, Avondale, O. Beck, Mar 1964 (fl.).
117464 PDD, Mt Albert, B. R. Young, Nov 1967 (fl.). A duplicate of 117464 sent to Kew was identified as *P. caerulea* L.
119939 Mangawhai, on pines, A. N. Sexton, Feb 1969 (fl. and fr.).

11. **Passiflora** 'Eynsford Gem' Figs. 39 - 41

This cultivar is distinguished from *P. caerulea* by the 3-lobed leaves (often the two basal lobes are partially divided). The tendrils rarely exceed 5 mm in length, but some may grow up to 15 cm. Consequently, the plants have a scrambling rather than a climbing habit. The petals and sepals are lilac above, and the corona filaments are white tipped with purple. No fruit have been found.

This hybrid was raised by Mr. Geeson at Haldon House, near Exeter, England, about 1885, by crossing *Passiflora caerulea* 'Constance Elliott', a large white-flowered form of *P. caerulea,* and *P. racemosa,* a red-flowered species. It is grown in the warmer districts of New Zealand as an ornamental climber.

Plants for this study were obtained from the nursery of A. W. Palmer & Sons Ltd., Auckland.

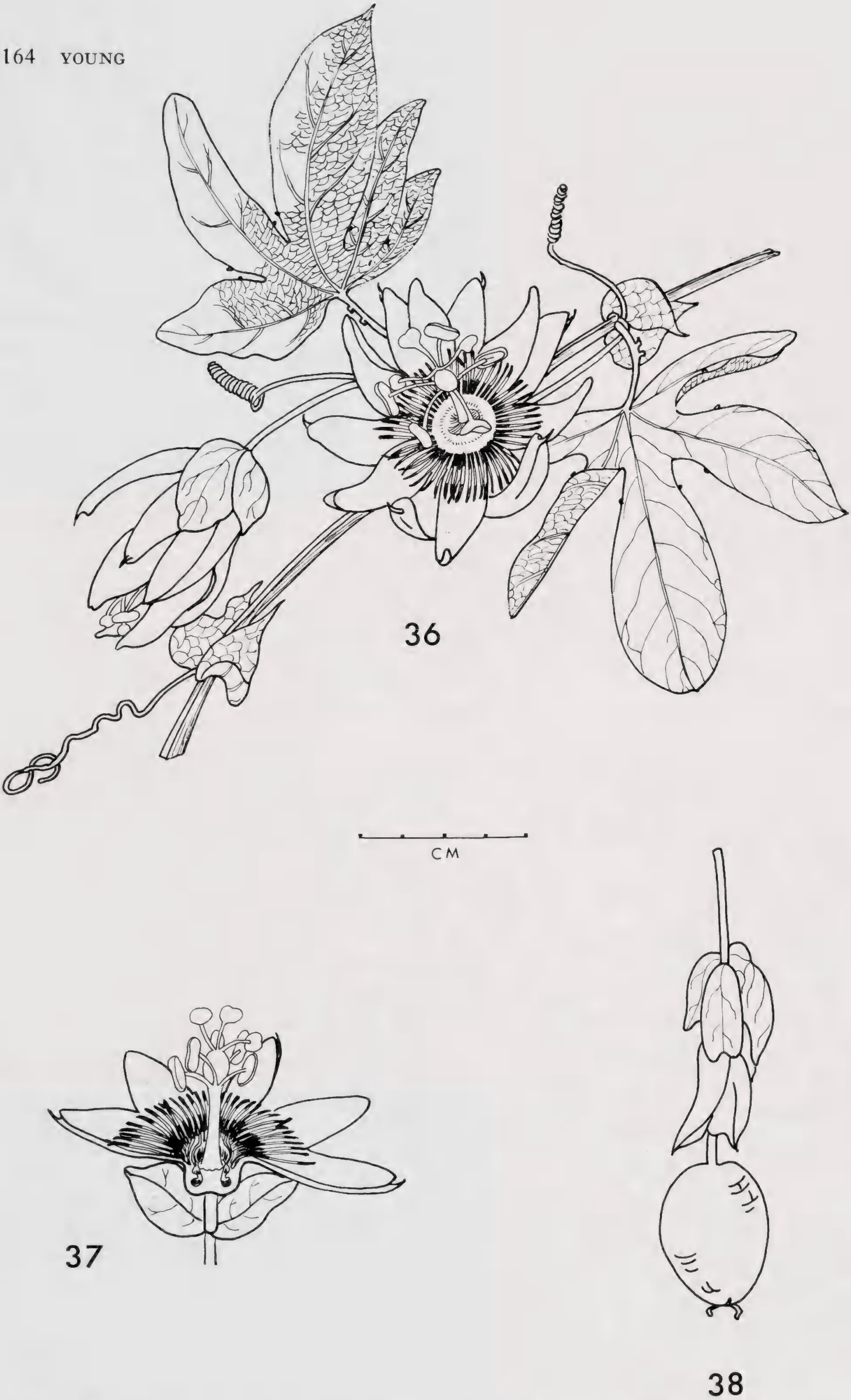


Fig. 36 Flowering branch of *P. caerulea* L.; 37 flower in longitudinal section; 38 fruit.

Fig. 39 Flowering shoot of *P*. 'Eynsford Gem'; 40 flower in longitudinal section; 41 bud.

Identification has been made from the description and illustration of Masters (1889, p. 492-3).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116166 Palmer's Nursery, Auckland, B. R. Young, Apr 1966 (fl.).
114770 PDD, Mt Albert, B. R. Young, Apr 1967 (fl.). A duplicate of 114770 sent to Kew was identified as *P. caerulea* L., cv.

12. **Passiflora** x **alato-caerulea** Lindl. Figs. 42 - 43

This hybrid differs from *P. caerulea* in that the leaves are 3-lobed, the lobes being broad, and red-veined beneath. It differs from *P.* 'Eynsford Gem' in being more robust, both in foliage and flowers. The stems are 4- or 5-angled, and the tendrils are well developed. The flowers are large and showy, 12 to 14 cm in diameter, with white sepals, tinged with lilac, and pale pink petals, also tinged with lilac. The corona filaments are purple at the base, banded with white and pink-lilac above, and tipped with white. Fruit are not formed.

Passiflora x *alato-caerulea* was raised by Mr. J. H. Masters at the nursery of Mr. W. Masters, Canterbury, England, in the early 1820s. He fertilised flowers of *P. alata* with pollen of *P. caerulea,* and obtained seed. Lindley mentioned in the description of *P.* x *alato-caerulea* (1824, p. 848) that among the seedlings were two variants, one with paler flowers and another much less in all its parts.

The epithet *pfordtii* was used for the hybrid some time before 1889 (Anon. 1889, p. 746), and X *Passiflora pfordtii* Hort. was formally described and illustrated by Degener in 1939 (Fam. 250). Lawrence (1960, p. 120 and 130) considers that the name *P. pfordtii* should be treated as a synonym of *P.* x *alato-caerulea* Lindl.

Cuttings of the hybrid were collected from Mr. Boot's garden at Warkworth, and a plant was obtained from the nursery of A. W. Palmer & Sons Ltd., Auckland. They match the descriptions and illustrations of *P.* x *alato-caerulea* Lindley and *P. pfordtii* Hort., but are known here as *P.* 'Empress Eugene'. This is a commercial synonym of *P.* 'Impératrice Eugénie' Lemaire. The specimens collected locally differ from Lemaire's description and illustration (1858, pl. 175) in several characters:—

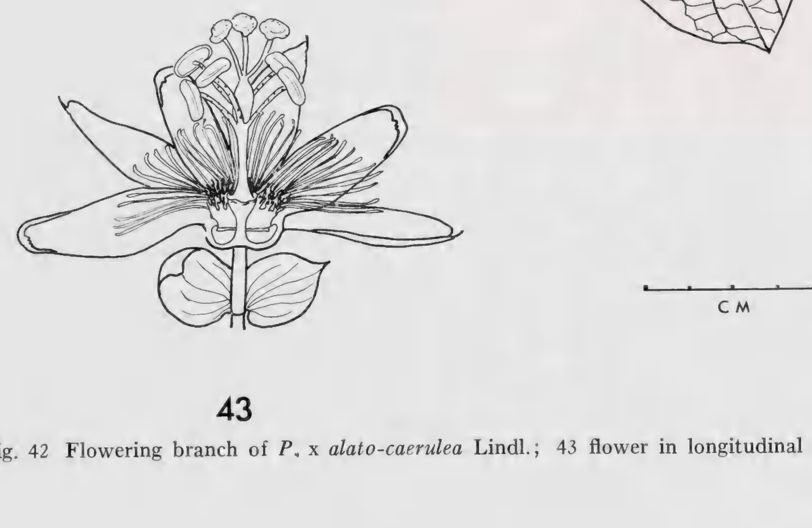
Plants collected at Warkworth and Auckland:	*P.* 'Impératrice Eugénie'
Stems angular.	Stems cylindrical.
Flowers scented.	Flowers not scented.
Corona filaments purple at base, banded with white and pink-lilac above, and tipped with white.	Corona filaments alternately striped with violet, blue and white.

Identification has been made from descriptions and illustrations of Lindley (1824, p. 848), Degener (1939, Fam. 250) and Lawrence (1960, p. 123).

Voucher specimens in the Herbarium of the Auckland Institute and Museum are:—

116156 Boot's garden, Warkworth, B. R. Young, Mar 1966 (fl.).
114469 PDD, Mt Albert, B. R. Young, Apr 1967 (fl.). A duplicate of 114469 sent to Kew was identified as "*P.* x *alato-caerulea* Lindl. and possibly the plant called *P.* x *munroi* Mast. (a synonym)."

42



43

Fig. 42 Flowering branch of *P*. x *alato-caerulea* Lindl.; 43 flower in longitudinal section.

Other species and cultivars listed in New Zealand nursery catalogues have not been found. They include the following: *Passiflora alata, P. bounapartea, P. exoniensis, P. grandiflora, P. manacata, P. middletoniana, P. quadrangularis, P. sangwellii, P.* 'Constance Elliott', *P.* 'Fragrant Beauty', *P.* 'Empress Eugene' or 'Impératrice Eugénie', and *P.* 'Oldfield Gem'.

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PALAU CAVE PAINTINGS ON AULONG ISLAND

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Abstract. Drawings of the principal motifs have been prepared by Linden Cowell from colour photographs.

The accompanying drawings were made by Linden Cowell of the University of Otago from colour photographs taken by Dr. H. DeWitt of the University of California. Dr. DeWitt visited the Palau group in 1957 as a marine biologist. He was guided to the cave on Aulong Island by Sumang, former guide and interpreter to Douglas Osborne in 1953. Osborne's description of the site (1966, p. 400) at Aulong 4 is:—

> "It is a cave or overhang high on the limestone cliff of the north-western end of Aulong . . . It is on what may be a first sea terrace or step. From the sea up, there is first the wave-cut notch, then 50 or 60 feet of rather sheer though climbable and partly vegetated cliff . . . The painted cave was . . . once the back of a larger one. It is now an overhang about 15 feet deep, and 15 to 18 feet high at the mouth, by about 40 feet long. There is an adjacent small room to the north which has a few pictographs. The two overhangs together would total about 60 feet of length. There are no sherds or deposits there . . . The cave is known as Ongewikl Yarsh, a place where pandanus mat sails were woven."

Osborne's record of the paintings is incomplete, and the present series, though not accompanied by a plan, appear to be a much clearer record of some of the principal motifs used. The designs are painted in red ochre on suitable, more or less smooth patches of the cave wall. An epidiascope projection technique was used by Linden Cowell in making the black and white drawings.

Fig. 1. A relatively smooth wall with some indentations. It illustrates the use of both stipple and solid line techniques to produce the paintings. On the lower edge of the area, a solid geometric design appears to overlay a more free flowing stipple design. In the upper left, a series of designs appear to intersect, while the centre and left hand top designs are isolated. The paintings on the left hand side are done on a much rougher surface and are consequently less clear.

Fig. 2. The central portion of this area is smooth and the outer edges are deeply indented. The central design appears to incorporate both a stipple and a solid design, the stipple pattern having a form which appears to vary from that of the solid design. In this whole area it looks as though a series of stipple designs have been overlaid and incorporated into later (?) solid line drawings.

Rec. Auckland Inst. Mus. 7: 171-173 March 31st 1970

Fig. 1

Fig. 2

Fig. 3

Fig. 3. This area is fairly smooth, with a number of bubbly projections and large rough areas, unpainted, at the top and bottom left hand corners. The designs are mainly solid line though some stippling is present, but not enough for any inferences to be made. The lining up of the main designs across the wall would suggest the hand of one artist. This series is partly depicted in Osborne (1966, Fig. 106, top left).

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THE LITTORAL MARINE MOLLUSCS OF NIUE ISLAND

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Abstract. Two hundred and three species of molluscs have been collected at Niue Island by Mr. N. McDowall between the years 1966-1968. These are listed together with six additional species from the Finlay and Sorrensen collections of Niue Island molluscs at the Auckland Institute and Museum. In the species list of Niue Island molluscs, figure references for each species have been cited. From a total of 209 Niue Island molluscs recorded, 83% are widely distributed throughout the Indo-Pacific, 14% are Pacific endemics and 3% are Polynesian endemics; none are endemic to Niue Island.

The molluscan fauna of Niue Island has, until recent times, been imperfectly known, and representative collections in Museums consisted of only small sample lots. The molluscan collections made by Mr. N. McDowall, a resident of Niue Island, during the years 1966-68, greatly supplement our knowledge of Niue Island's molluscs and their relationship to other Pacific faunules. Contrary to expectations, the bulk of Niue Island molluscs show a close relationship to molluscs of the Melanesian region, despite the island's geographical position within the Polynesian zoogeographic province which extends westward to the Tongan trough.

ZOOGEOGRAPHY

Niue Island, a small coral atoll situated at Lat. 19°02′ S and Long. 169°50′ W, is a New Zealand territory, annexed in 1901 and administered by the Department for Island Territories. Only $13\frac{3}{4}$ x $11\frac{1}{2}$ miles (22.1-34.6 km) in dimension, Niue Island lies approximately 300 miles (483 km) to the east of the Tonga group and 580 miles (933.8 km) west of the Cook Islands. Niue is a coral atoll which has undergone two successive uplifts which were responsible for the formation of the lagoon bed in the centre of the Island, and occasional deep chasms such as may be found at Matapa and Vailoa. Beneath the topsoil of the old lagoon bed is coral sand, which is prolific in Pleistocene fossils, especially *Strombus mutabilis* Swainson.

The island consists of two terraces: the west coast terrace *ca.* 400 yards (365.8 m) in width, accommodates western villages and rises to almost 100 feet (30.5 m). Beyond this terrace is the second cliff, eroded to form a steep hill, and rising to the island's highest point of 220 feet (67.1 m). A shore reef skirts the island which apart from small breaks is almost continuous. At Alofi, the main town on the west coast, the reef extends for almost 2 miles (3.2 km) northward, and attains a width of about 80 yards (73.1 m). Towards the north coast there are small reefs at Vaohina, Namoui and Oneone. A larger reef commences at Hikutavake and extends northward with occasional small breaks. Kavata reef, at the extreme north point of the island, is about 2 miles (3.2 km) long and fairly wide; there is a paucity of molluscs on

this reef. On the eastern coast of the island are small stretches of reef at Tuavao, Vaitafe, Motu, Hiola, Tautu, Vaotoi, Uani and Hakupu. At Tepa Point in the south, a reef extends for 3 miles (4.8 km) to Fakaava. West coast reefs are flat-topped coral terraces which slowly rise towards the reef edge; within the intertidal zone, coral sand is at a minimum. Beyond the reef edge there is a sharp drop to a depth of 40 feet (12.2 m) to a sand and coral-rubble terrace; from this terrace the sea-bottom gradually slopes downward for several hundred yards and is followed by a steep descent to deeper water.

Mean winter water temperatures taken in 1966 were 24.3°C, mean summer water temperatures 25.8°C. A spot check taken by Mr. McDowall in December 1967 gave a water temperature reading of 26.9°C.

The majority of Niue Island molluscs are widely distributed in the Indo-Pacific region, and the number of Pacific and Polynesian endemics is small. Orr-Maes (1967), in her study of the littoral marine molluscs of the isolated Indian Ocean Cocos-Keeling Islands, obtained rather similar distributional figures to those of Niue Island: Cocos-Keeling 82% of Indo-Pacific endemics (Niue I.—83%); Cocos-Keeling Pacific endemics 15% (Niue I.—14%, but no Indian Ocean endemics); Cocos-Keeling Indian Ocean endemics 3% (Niue I.—Polynesian endemics 3%). These figures tend to lend support to the theory of an Indo-Pacific molluscan fauna origin in the central Indo-Pacific arc (Philippines-Indonesian region), and a subsequent migration to the West and East. Towards the fringe areas of the east-west distribution, Indian Ocean and Pacific Ocean endemics have evolved through time and isolation; not only does the number of species decline in these east-west distributional fringe areas, but the percentage of Indian and Pacific Ocean endemics is more or less proportionate. On Cocos-Keeling Islands, the littoral molluscs were predominantly gastropods, while pelecypods, scaphopods and Amphineura were recorded in very small numbers. This is the case on Niue Island, where the paucity of pelecypods and scaphopods is conspicuous. Due to their shorter planktonic life, most pelecypods and scaphopods did not survive the early migrational drift towards the central Pacific.

GASTROPODA

Family TROCHIDAE

Genus TROCHUS Linnaeus, 1758

Trochus maculatus Linnaeus, 1758 — Kira, 1959, pl. 9; fig. 1a, b

Family TURBINIDAE

Genus TURBO Linnaeus, 1758

Turbo(Marmarostoma)argyrostomus Linnaeus, 1758 Kira, 1959, pl. 9; fig. 6

Family NERITIDAE

Genus NERITA Linnaeus, 1758

Nerita albicilla Linnaeus, 1758 — Kira, 1959, pl. 11; fig. 15
N.plicata Linnaeus, 1758 — Kira, 1959, pl. 11; fig. 17
N.polita Linnaeus, 1758 — Kira, 1959, pl. 11; fig. 19

Family ARCHITECTONIDAE

Genus HELIACUS d'Orbigny, 1842

Heliacus variegatus (Gmelin, 1791) — Kira, 1959, pl. 12; fig. 4

Family CERITHIIDAE

Genus CERITHIUM Bruguière, 1792

Cerithium columna Sowerby, 1855 — Habe, 1961, pl. 13; fig. 13
C.nodulosum Bruguière, 1792 — Kira, 1959, pl. 12; fig. 22

Genus RHINOCLAVIS Swainson, 1840

Rhinoclavis sinensis (Gmelin, 1791) — Kira, 1959, pl. 12; fig. 19

Family EULIMIDAE

Genus BALCIS Leach, 1847

Balcis c.f. **B.cumingi** (A. Adams, 1854) — Orr-Maes, 1967, pl. 8; fig. K

Family CALYPTRAEIDAE

Genus CHEILEA Modeer, 1793

Cheilea equestris (Linnaeus, 1758) — Habe & Kosuge, 1967, pl. 15; fig. 2

Family HIPPONICIDAE

Genus HIPPONIX Defrance in Blainville, 1819

Hipponix conicus (Schumacher, 1817) — Cernohorsky, 1968b, pl. 41; figs. 1-8

Family STROMBIDAE

Genus STROMBUS Linnaeus, 1758

Strombus(Tricornis)thersites Swainson, 1823 — Abbott, 1960, pl. 17; fig. 1-2
S.(Euprotomus)vomer vomer (Röding, 1798) — Abbott, 1960, pl. 14; fig. 7-8

This species was known to range as far eastward as the Tonga Islands, and the Niue Island record is a new range extension.

S.(Canarium)maculatus Sowerby, 1842 — Abbott, 1960, pl. 20; fig. 13-14

The Niue Island record of this specimen is a new westward extension of this Micro-Polynesian endemic.

S.(Canarium)mutabilis Swainson, 1821 — Abbott, 1960, pl. 20; fig. 15-16
S.(Canarium)wilsoni Abbott, 1967 — Abbott, 1967, pl. 328; fig. 1-5

This recently described species was known to range as far eastward as the Fiji Islands. This new record extends the species' range considerably further east towards Polynesia.

S.(Gibberulus)gibberulus gibbosus (Röding, 1798) — Abbott, 1960, pl. 14; fig. 26

Genus LAMBIS Röding, 1798

Lambis truncata sebae (Kiener, 1843) — Abbott, 1961, pl. 121; fig. 9

Family NATICIDAE

Genus POLINICES Montfort, 1810

Polinices melanostoma (Gmelin, 1791) — Orr-Maes, 1967, pl. 9; fig. E

Family OVULIDAE

Genus OVULA Bruguière, 1789

Ovula ovum (Linnaeus, 1758) — Cernohorsky, 1967, pl. 20; fig. 118-9

Genus CALPURNUS Montfort, 1810

Calpurnus verrucosus (Linnaeus, 1758) — Cernohorsky, 1967, pl. 21; fig. 122
C.(Procalpurnus)lacteus (Lamarck, 1811) — Cernohorsky, 1967, pl. 21; fig. 121

Genus PSEUDOCYPRAEA Schilder, 1927

Pseudocypraea adamsonii (Sowerby, 1832) — Cernohorsky, 1968a, pl. 51; fig. 14

Family TRIVIIDAE

Genus Trivirostra Jousseaume, 1884

Trivirostra hordacea (Kiener, 1843)	Cernohorsky, 1968a, pl. 51; fig. 19
T.oryza (Lamarck, 1811)	Cernohorsky, 1967, pl. 22; fig. 133

Genus Lachryma Sowerby [1832]

Lachryma sulcifera (Sowerby, 1832)	Cernohorsky, 1968a, pl. 52; fig. 21a-22a

Family CYPRAEIDAE

Genus Mauritia Troschel, 1863

Mauritia arabica (Linnaeus, 1758)	Cernohorsky, 1967, pl. 9; fig. 40
M.depressa (Gray, 1824)	Cernohorsky, 1967, pl. 9; fig. 41, 41a
M.maculifera Schilder, 1932	Cernohorsky, 1967, pl. 10; fig. 43
M.mauritiana (Linnaeus, 1758)	Cernohorsky, 1967, pl. 10; fig. 45
M.scurra (Gmelin, 1791)	Cernohorsky, 1967, pl. 10; fig. 46

Genus Talparia Troschel, 1863

Talparia talpa (Linnaeus, 1758)	Cernohorsky, 1967, pl. 8; fig. 31
T.isabella (Linnaeus, 1758)	Cernohorsky, 1967, pl. 8; fig. 32

Genus Cypraea Linneaus, 1758

Cypraea tigris (Linnaeus, 1758)	Cernohorsky, 1967, pl. 8; fig. 30

Genus Lyncina Troschel, 1863

Lyncina carneola (Linnaeus, 1758)	Cernohorsky, 1967, pl. 8; fig. 35
L.schilderorum (Iredale, 1939)	Cernohorsky, 1967, pl. 9; fig. 38
L.lynx (Linnaeus, 1758)	Cernohorsky, 1967, pl. 8; fig. 36
L.ventriculus (Lamarck, 1811)	Cernohorsky, 1967, pl. 8; fig. 37

The radula of the species confirms the placement of the species in the genus *Lyncina* (Fig. 1)

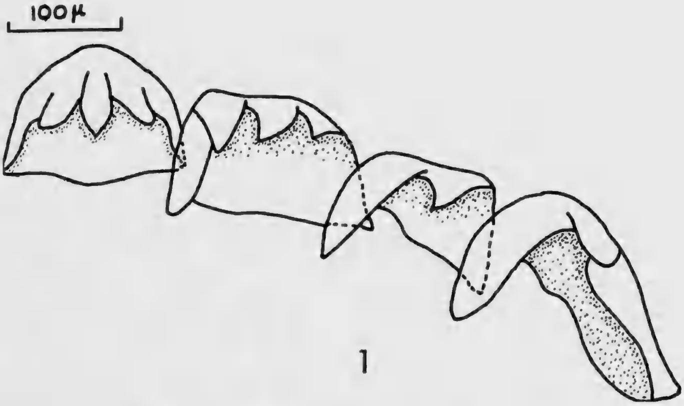

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Fig. 1. Half-row of radula of *Lyncina ventriculus* (Lamarck) from Niue Island.

Genus Chelycypraea Schilder, 1927

Chelycypraea testudinaria (Linnaeus, 1758)	Cernohorsky, 1967, pl. 8; fig. 29

Genus PUSTULARIA Swainson, 1840

Pustularia cicercula (Linnaeus, 1758) Cernohorsky, 1967, pl. 10; fig. 47

This is the species known in recent literature as *Pustularia bistrinotata* Schilder & Schilder, 1937.

P.childreni (Gray, 1825) Cernohorsky, 1967, pl. 10; fig. 48
P.globulus (Linnaeus, 1758) Cernohorsky, 1967, pl. 11; fig. 51
P.margarita (Dillwyn, 1817) Cernohorsky, 1967, pl. 11; fig. 52
P.mariae Schilder, 1927 Cernohorsky, 1967, pl. 10; fig. 49

Genus MONETARIA Troschel, 1863

Monetaria annulus (Linnaeus, 1758) Cernohorsky, 1967, pl. 11; fig. 53
M.moneta (Linnaeus, 1758) Cernohorsky, 1967, pl. 11; fig. 54

Genus EROSARIA Troschel, 1863

Erosaria caputserpentis (Linnaeus, 1758) Cernohorsky, 1967, pl. 12; fig. 59
E.dillwyni (Schilder, 1922) Cernohorsky, 1967, pl. 12; fig. 58
E.erosa (Linnaeus, 1758) Cernohorsky, 1967, pl. 12; fig. 61
E.helvola (Linnaeus, 1758) Cernohorsky, 1967, pl. 12; fig. 63
E.poraria (Linnaeus, 1758) Cernohorsky, 1967, pl. 13; fig. 65

Genus STAPHYLAEA Jousseaume, 1884

Staphylaea limacina (Lamarck, 1811) Cernohorsky, 1967, pl. 13; fig. 69
S.nucleus (Linnaeus, 1758) Cernohorsky, 1967, pl. 13; fig. 68

Genus ERRONEA Troschel, 1863

Erronea caurica (Linnaeus, 1758) Cernohorsky, 1967, pl. 14; fig. 73

Genus NOTADUSTA Schilder, 1935

Notadusta punctata (Linnaeus, 1771) Cernohorsky, 1967, pl. 16; fig. 87

Genus PALMADUSTA Iredale, 1930

Palmadusta asellus (Linnaeus, 1758) Cernohorsky, 1967, pl. 16; fig. 88
P.fimbriata (Gmelin, 1791) Cernohorsky, 1967, pl. 17; fig. 94
P.irrorata (Gray, 1828) Cernohorsky, 1967, pl. 13; fig. 67
P.minoridens (Melvill, 1901) Cernohorsky, 1967, pl. 17; fig. 96
P.serrulifera Schilder & Schilder, 1938 Cernohorsky, 1967, pl. 17; fig. 99

Genus BISTOLIDA Cossmann, 1920

Bistolida goodallii (Sowerby, 1832) Cernohorsky, 1967, pl. 18; fig. 102
B.stolida (Linnaeus, 1758) Cernohorsky, 1967, pl. 19; fig. 108
B.ursellus (Gmelin, 1791) Cernohorsky, 1967, pl. 19; fig. 111

Family CASSIDAE

Genus CASSIS Scopoli, 1777

Cassis cornuta (Linnaeus, 1758) Abbott, 1968, pl. 3; fig. 1-4

Genus CASMARIA H. & A. Adams, 1853

Casmaria erinaceus erinaceus (Linnaeus, 1758) Abbott, 1968, pl. 14; fig. 7-12
C.ponderosa ponderosa (Gmelin, 1791) Abbott, 1968, pl. 14; fig. 1-6

Family CYMATIIDAE

Genus CYMATIUM Röding, 1798

Cymatium muricinum (Röding, 1798) Cernohorsky, 1967, pl. 5; fig. 19
C.nicobaricum (Röding, 1798) Cernohorsky, 1967, pl. 3; fig. 11
C.pileare (Linnaeus, 1758) Cernohorsky, 1967, pl. 3; fig. 9, 10

Genus Distorsio Röding, 1798

Distorsio anus (Linnaeus, 1758) Cernohorsky, 1967, pl. 6; fig. 23

Genus Charonia Gistel, 1848

Charonia tritonis (Linnaeus, 1758) Cernohorsky, 1967, pl. 7; fig. 26

Family BURSIDAE

Genus Bursa Röding, 1798

Bursa bubo (Linnaeus, 1758) Cernohorsky, 1967, pl. 1; fig. 1
B.bufonia (Gmelin, 1791) Cernohorsky, 1967, pl. 2; fig. 5
B.cruentata (Sowerby, 1835) Cernohorsky, 1967, pl. 2; fig. 7

Two forms of this species occur on Niue Island: the form with distinct black columellar bars, and the one with a plain white columella.

B.granularis (Röding, 1798) Cernohorsky, 1967, pl. 1; fig. 4
B.rosa Perry, 1811 Cernohorsky, 1967, pl. 1; fig. 3

Family TONNIDAE

Genus Tonna Brünnich, 1772

Tonna perdix (Linnaeus, 1758) Kira, 1959, pl. 22; fig. 6

Family MURICIDAE

Genus Chicoreus Montfort, 1810

Chicoreus brunneus (Link, 1807) Cernohorsky, 1967, pl. 25; fig. 148

Genus Pterynotus Swainson, 1833

Pterynotus triqueter (Born, 1778) Cernohorsky, 1967, pl. 26; fig. 160

Genus Thais Röding, 1798

Thais armigera affinis (Reeve, 1846) Reeve, 1846, pl. 15; fig. 77
T.intermedia (Kiener, 1836) Cernohorsky, 1967, pl. 28; fig. 173

Genus Mancinella Link, 1807

Mancinella tuberosa (Röding, 1798) Cernohorsky, 1967, pl. 28; fig. 174

Genus Drupa Röding, 1798

Drupa clathrata (Lamarck, 1816) Habe & Kosuge, 1967, pl. 27; fig. 29
D.morum Röding, 1798 Cernohorsky, 1967, pl. 23; fig. 176
D.ricinus (Linnaeus, 1758) Cernohorsky, 1967, pl. 28; fig. 175 & pl. 29; f. 177

Both forms, the pure white and the orange-spotted form, occur on Niue Island.

Genus Drupina Dall, 1923

Drupina grossularia (Röding, 1798) Cernohorsky, 1967, pl. 29; fig. 179
D.rubusidaeus (Röding, 1798) Cernohorsky, 1967, pl. 29; fig. 180

Genus Drupella Thiele, 1925

Drupella cornus (Röding, 1798) Habe & Kosuge, 1967, pl. 27; fig. 20

Genus Morula Schumacher, 1817

Morula granulata (Duclos, 1832) Cernohorsky, 1967, pl. 29; fig. 178
M.uva (Röding, 1798) Habe, 1961, pl. 26; fig. 1
M.marginatra (Blainville, 1832) Orr-Maes, 1967, pl. 11; fig. K

Genus Nassa Röding, 1798

Nassa serta (Bruguière, 1789) Cernohorsky, 1967, pl. 29; fig. 183

Family MAGILIDAE

Genus RAPA Röding, 1798

Rapa rapa (Linnaeus, 1758)	Kira, 1959, pl. 24; fig. 17

Genus CORALLIOPHILA H. & A. Adams, 1853

Coralliophila violacea (Kiener, 1836)	Kira, 1959, pl. 25; fig. 2

Family BUCCINIDAE

Genus CADUCIFER Dall, 1904

Caducifer truncatus (Hinds, 1844)	Habe, 1961, pl. 31; fig. 4

Genus CANTHARUS Röding, 1798

Cantharus undosus (Linnaeus, 1758)	Kira, 1959, pl. 26; fig. 8

Genus ENGINA Gray, 1839

Engina mendicaria (Linnaeus, 1758)	Kira, 1959, pl. 26; fig. 1

Family COLUBRARIIDAE

Genus COLUBRARIA Schumacher, 1817

Colubraria tortuosa (Reeve, 1844)	Cernohorsky, 1967, pl. 7; fig. 28

Family NASSARIIDAE

Genus NASSARIUS Dumeril, 1806

Nassarius graniferus (Kiener, 1834)	Habe, 1961, pl. 32; fig. 12
N.livescens (Philippi, 1849)	Kira, 1959, pl. 28; fig. 17
N.papillosus (Linnaeus, 1758)	Kira, 1959, pl. 28; fig. 28

Family FASCIOLARIIDAE

Genus LATIRUS Montfort, 1810

Latirus(Pleuroploca)filamentosus (Röding, 1798)	Habe & Kosuge, 1966, pl. 25; fig. 10
L.(Mazzalina)smaragdulus (Linnaeus, 1758)	Kira, 1959, pl. 30; fig. 19

Genus PERISTERNIA Mörch, 1852

Peristernia nassatula (Lamarck, 1822)	Kira, 1959, pl. 30; fig. 8

Family VASIDAE

Genus VASUM Röding, 1798

Vasum ceramicum (Linnaeus, 1758)	Abbott, 1959, pl. 1; fig. 1

Family OLIVIDAE

Genus OLIVA Bruguière, 1789

Oliva annulata (Gmelin, 1791)	Cernohorsky, 1967, pl. 46; fig. 334
O.duclosi Reeve, 1850	Habe & Kosuge, 1966, pl. 27; fig. 4

Family MITRIDAE

Genus MITRA Röding, 1798

Mitra chrysalis Reeve, 1844	Cernohorsky, 1967, pl. 30; fig. 190
M.coffea Schubert & Wagner, 1829	Cernohorsky, 1967, pl. 30; fig. 192
M.coronata Lamarck, 1811	Cernohorsky, 1967, pl. 31; fig. 195
M.ferruginea Lamarck, 1811	Cernohorsky, 1967, pl. 31; fig. 198
M.imperialis Röding, 1798	Cernohorsky, 1967, pl. 31; fig. 201
M.lugubris Swainson, 1821	Cernohorsky, 1967, pl. 31; fig. 202
M.mitra (Linnaeus, 1758)	Cernohorsky, 1967, pl. 32; fig. 204

M.stictica (Link, 1807)	Cernohorsky, 1967, pl. 33; fig. 218
M.(Strigatella) acuminata Swainson, 1824	Cernohorsky, 1967, pl. 34; fig. 225
M.(Strigatella) auriculoides Reeve, 1845	Cernohorsky, 1967, pl. 30; fig. 186
M.(Strigatella) colombelliformis Kiener, 1838	Cernohorsky, 1967, pl. 31; fig. 193
M.(Strigatella) decurtata Reeve, 1844	Reeve, 1844, pl. 20; fig. 154

For the radula of this species, see Fig. 2.

2

Fig. 2. Half-row of radula of *Mitra (Strigatella) decurtata* Reeve from Niue Island.

M.(Strigatella) fastigium Reeve, 1845	Cernohorsky, 1967, pl. 34; fig. 229

This is the earliest name applicable to this species. *Strigatella fuscescens* Pease, 1860, and *Mitra brunnea* Pease, 1868, are synonyms. *Mitra oleacea* Reeve, 1844 (non Cernohorsky, 1965) is a chronologically prior name for the species *M.quoyi* Deshayes & M. Edwards, 1844 (a *nom.pro Mitra nigra* Quoy & Gaimard, 1833—non Gmelin, 1791).

M.(Strigatella) litterata Lamarck, 1811	Cernohorsky, 1967, pl. 34; fig. 227
M.(Strigatella)paupercula (Linnaeus, 1758)	Cernohorsky, 1967, pl. 34; fig. 228
M.(Strigatella) pellisserpentis Reeve, 1844	Cernohorsky, 1967, pl. 34; fig. 230
M.(Strigatella) typha Reeve, 1845	Reeve, 1845, pl. 33; fig. 267

Genus Neocancilla Cernohorsky, 1966

Neocancilla clathrus (Gmelin, 1791) — Finlay coll.	Cernohorsky, 1967, pl. 35; fig. 238

Genus Imbricaria Schumacher, 1817

Imbricaria conovula (Quoy & Gaimard, 1833)	Cernohorsky, 1967, pl. 37; fig. 253
I.punctata (Swainson, 1821)	Cernohorsky, 1967, pl. 37; fig. 256

Genus Pterygia Röding, 1798

Pterygia nucea (Gmelin, 1791)	Cernohorsky, 1967, pl. 38; fig. 262

Genus Vexillum Röding, 1798

Vexillum(Costellaria)cancellarioides (Anton, 1839)	Cernohorsky, 1967, pl. 44; fig. 323

The species is generally assigned to the genus *Pusia,* the radula, however, is of the same pattern as *Vexillum* Röding.

V.(Costellaria)festum (Reeve, 1845) — Finlay coll.	Cernohorsky, 1967, pl. 40; fig. 282

Genus Pusia Swainson, 1840

Pusia consanguinea (Reeve, 1845)	Cernohorsky, 1967, pl. 45; fig. 324
P.diutenera (Hervier, 1897) — Finlay coll.	—
P.hervieri (Dautzenberg & Bouge, 1923)	Dautzenberg & Bouge, 1923, pl.2; fig.10,11
P.microzonias (Lamarck, 1811)	Cernohorsky, 1967, pl. 45; fig. 328
P.millecostata (Broderip, 1836)	Cernohorsky, 1967, pl. 44; fig. 321

Mitra adamsonii Reeve, 1844, is a synonym of *Pusia millecostata* (Broderip).

P.picea (Pease, 1860)	J. Cate, 1963, pl. 7; fig. 27-29
P.moelleri (Küster, 1840)	—

Mitra flammulata Pease, 1868, and *M.baldwinii* Melvill, 1899, are synonyms of *Pusia moelleri* (Küster).

P.rosea (Broderip, 1836)	Reeve, 1844, pl. 36; fig. 300
P.speciosa (Reeve, 1844) — Finlay coll.	Reeve, 1844, pl. 19; fig. 148
P.suavis (Souverbie, 1875)	J. Cate, 1963, pl. 6; fig. 23

This species is occasionally confused with *Mitra exquisita* Garrett,1873. Garrett's syntypes are extant in the Bernice P. Bishop Museum in Honolulu; they are a *Thala* species and conspecific with *Vexillum(Thala) mirificum* (Reeve, 1845).

P.tuberosa (Reeve, 1845)	Cernohorsky, 1967, pl. 45; fig. 333
P.turben (Reeve, 1845)	J. Cate, 1962, pl. 34; fig. 7-8
P.tusa (Reeve, 1845)	J. Cate, 1963, pl. 6; fig. 15-18

The species illustrated by J. Cate (1963) is *Pusia tusa* (Reeve) and not *P.alveolus* (Reeve).

Family HARPIDAE

Genus Harpa Röding, 1798

Harpa amouretta Röding, 1798	Kira, 1959, pl. 31; fig. 16

Family TURRIDAE

Genus Lienardia Jousseaume, 1884

Lienardia rubida (Hinds, 1843)	Powell, 1966, pl. 17; fig. 21

Genus Lovellona Iredale, 1917

Lovellona atramentosa (Reeve, 1849)	Powell, 1966, pl. 10; fig. 13

Family CONIDAE

Genus Conus Linnaeus, 1758

Conus arenatus Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 14; fig. 27
C.aristophanes Sowerby, 1857	Cernohorsky, 1964, pl. 18; fig. 67
C.auricomus Hwass in Bruguière, 1792	Habe, 1961, pl. 37; fig. 3
C.balteatus Sowerby, 1833	Cernohorsky, 1964, pl. 16; fig. 49
C.catus Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 15; fig. 42
C.ceylanensis Hwass in Bruguière, 1792	Reeve 1843, pl. 37; fig. 199
C.chaldaeus (Röding, 1798)	Cernohorsky, 1964, pl. 18; fig. 70
C.coronatus Gmelin, 1791	Cernohorsky, 1964, pl. 18; fig. 68
C.cylindraceus Broderip & Sowerby, 1830	Cernohorsky, 1964, pl. 17; fig. 58
C.distans Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 12; fig. 4
C.ebraeus Linnaeus, 1758	Cernohorsky, 1964, pl. 18; fig. 69
C.eburneus Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 12; fig. 3
C.flavidus Lamarck, 1810	Cernohorsky, 1964, pl. 16; fig. 48
C.geographus Linnaeus, 1758	Cernohorsky, 1964, pl. 15; fig. 37
C.imperialis Linnaeus, 1758	Cernohorsky, 1964, pl. 12; fig. 11
C.litoglyphus Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 17; fig. 61
C.litteratus Linnaeus, 1758	Cernohorsky, 1964, pl. 12; fig. 2
C.lividus Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 16; fig. 50
C.marmoreus Linnaeus, 1758	
a. forma **bandanus** Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 12; fig. 10
b. forma **nigrescens** Sowerby, 1859	—
C.miles Linnaeus, 1758	Cernohorsky, 1964, pl. 12; fig. 7
C.miliaris Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 18; fig. 72
C.mitratus Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 17; fig. 59
C.moreleti Crosse, 1858	Cernohorsky, 1964, pl. 16; fig. 52
C.nussatella Linnaeus, 1758	Cernohorsky, 1964, pl. 17; fig. 57
C.omaria Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 13; fig. 19

C.pulicarius Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 14; fig. 28
C.rattus Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 18; fig. 74
C.retifer Menke, 1829	Cernohorsky, 1964, pl. 13; fig. 25
S.sanguinolentus Quoy & Gaimard, 1833	Cernohorsky, 1964, pl. 16; fig. 51
C.scabriusculus Dillwyn, 1817	Cernohorsky, 1964, pl. 15; fig. 36
C.tenuistriatus Sowerby, 1858	Cernohorsky, 1967, pl. 59; fig. 438
C.textile Linnaeus, 1758	Cernohorsky, 1964, pl. 13; fig. 23
C.tulipa Linnaeus, 1758	Cernohorsky, 1964, pl. 15; fig. 38
C.varius Linnaeus, 1758	Cernohorsky, 1964, pl. 14; fig. 35
C.vexillum Gmelin, 1791	Cernohorsky, 1964, pl. 12; fig. 5
C.vitulinus Hwass in Bruguière, 1792	Cernohorsky, 1964, pl. 14; fig. 32

Family TEREBRIDAE

Genus Terebra Bruguière, 1789

Terebra (Decorihastula)affinis Gray, 1834	Cernohorsky, 1967, pl. 49; fig. 349
T.(Perirhoe)babylonia Lamarck, 1822	Cernohorsky, 1967, pl. 49; fig. 355
T.(Oxymeris) crenulata (Linnaeus, 1758)	Cernohorsky, 1967, pl. 50; fig. 361
T.(Subula)dimidiata (Linnaeus, 1758)	Cernohorsky, 1967, pl. 50; fig. 362
T.(Oxymeris)felina (Dillwyn, 1817)	Cernohorsky, 1967, pl. 50; fig. 364

Family TRIPHORIDAE

Genus Triphora Blainville, 1828

Triphora pallida (Pease, 1870) —

Genus Iniforis Jousseaume, 1884

Iniforis formosula (Hervier, 1897) Habe & Kosuge, 1966, pl. 41; fig. 49

Genus Cautotriphora Laws, 1940

Cautotriphora pavimenta (Laseron, 1958) Kosuge, 1966, pl. 1; fig. 4

Genus Viriola Jousseaume, 1884

Viriola incisa (Pease, 1860) Kosuge, 1961, pl. 22; fig. 9

Genus Mastonia Hinds, 1843

Mastonia cingulifera (Pease, 1860) Habe & Kosuge, 1966, pl. 41; fig. 11

M.undata (Kosuge, 1962) Kosuge, 1962, pl. 8; fig. 1

The species has not been previously recorded outside its type-locality of Amami Islands, Japan.

M.ustulata (Hervier, 1897) Habe & Kosuge, 1966, pl. 41; fig. 6

Family HYDATINIDAE

Genus Aplustrum Schumacher, 1817

Aplustrum aplustrum (Linnaeus, 1758) Kira, 1959, pl. 39; fig. 14

Genus Micromelo Pilsbry, 1894

Micromelo guamensis (Quoy & Gaimard, 1825) Orr-Maes, 1967, pl. 18; fig. A

Family ATYIDAE

Genus Atys Montfort, 1810

Atys cylindrica (Helbling, 1779) Orr-Maes, 1967, pl. 17; fig. K

Family UMBRACULIDAE

Genus Umbraculum Schumacher, 1817

Umbraculum sinicum (Gmelin, 1791) Orr-Maes, 1967, pl. 14; fig. K

Family ELLOBIIDAE

Genus MELAMPUS Montfort, 1810

Melampus castaneus (Mühlfeld, 1818)—Sorrensen coll. Orr-Maes, 1967, pl. 14; fig. I
M.flavus (Gmelin, 1701)—Sorrensen coll. Orr-Maes, 1967, pl. 14; fig. J

SCAPHOPODA

Family DENTALIIDAE

Dentalium sp.

AMPHINEURA

Family CHITONIDAE

Chiton sp.

PELECYPODA

Family PTERIIDAE

Genus PTERIA Scopoli, 1777

Pteria penguin (Röding, 1798) Kira, 1959, pl. 71; fig. 9

Family LUCINIDAE

Genus CODAKIA Scopoli, 1777

Codakia punctata (Linnaeus, 1758) Kira, 1959, pl. 53; fig. 8
C.tigerina (Linnaeus, 1758) Kira, 1959, pl. 53; fig. 5

Family CARDIIDAE

Genus FRAGUM Röding, 1798

Fragum fragum (Linnaeus, 1758) Kira, 1959, pl. 54; fig. 14

Family TRIDACNIDAE

Genus TRIDACNA Lamarck, 1799

Tridacna maxima (Röding, 1798) Habe & Kosuge, 1966, pl. 61; fig. 4

Family TELLINIDAE

Genus SCUTARCOPAGIA Pilsbry, 1918

Scutarcopagia scobinata (Linnaeus, 1758) Kira, 1959, pl. 59; fig. 24

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THE TAXONOMY OF SOME AUSTRAL-NEOZELANIC CYMATIIDAE (MOLLUSCA : GASTROPODA)

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Abstract. A living specimen of *Proxicharonia palmeri* Powell, has been collected at the Poor Knights Islands during a recent expedition. The dentition is compared to *Austrotriton parkinsonia* (Perry) from the same locality, and the taxonomic value of related genera is discussed.

Genus Proxicharonia Powell, 1938

Type-species (OD - Art.67(i) of ICZN) *Charonia(Charoniella)arthritica* Powell & Bartrum, 1929 (Awamoan, Lower Miocene)

1929. (*Charoniella*) Powell & Bartrum, Trans.Proc.N.Z. Inst.,60(3):426 (November, 1929) [non Thiele, 1929, September]

1938. *Proxicharonia* Powell, Trans.Proc.Roy.Soc.N.Z., 68(3):373 (*nom.nov.pro Charoniella* Powell & Bartrum, 1929)

The genus *Proxicharonia* has been established for New Zealand Miocene cymatid species, which are said to differ from species of *Austrotriton* Cossman, in features of more slender shape, narrower and more oval aperture and adpressed varices. Three fossil species are generally assigned to the genus: *Proxicharonia neozelanica* (Marshall & Murdoch, 1923) from Target Gully (Awamoan), *P.clifdenensis* (Finlay, 1924) from Clifden (Altonian) and *P.arthritica,* the type of the genus from Waiheke I. (Otaian) (Fig. 1).

In 1967 Powell described the first living species *Proxicharonia palmeri* (Fig. 2), from 140 feet (42.7 m) at Poor Knights Islands. The description was based on 2 empty shells, and the holotype itself is an immature specimen with feebly developed labial denticles. During the recent Auckland University-Dominion-Auckland Museums expedition to the Poor Knights Islands, a living specimen was obtained from 17-20 fathoms (31.1 - 36.6 m). In the living animal, the sole of the foot is white, the dorsum creamy-fawn, and the sides of the foot, head and penis are speckled with bright yellow; the tentacles are short and stubby and the eyes are small and black.

The radula of *Proxicharonia palmeri* (Fig. 3), has a rhachidian with a massive central cusp and 3 small side-cusps, and a concavely excavated base; the lateral and inner marginal are denticulate on the cutting edge, while the outer marginal is simple. A serrated or simple cutting edge of the lateral and marginals in Cymatiidae, is a variable character, and both types may occur in species of the same genus. The radula pattern of *P.palmeri* is essentially the same in structure as the radula of *Austrotriton parkinsonia* (Perry), and rather similar to *Argobuccinum ranelliformis tumidum* (Dunker) as figured by Powell (1933, fig. 8). The operculum of *P.palmeri* (Fig. 5) has a latero-basal nucleus and is undistinguishable from the operculum of *Austrotriton parkinsonia.* The penis (Fig. 4) is similar in structure to the penal

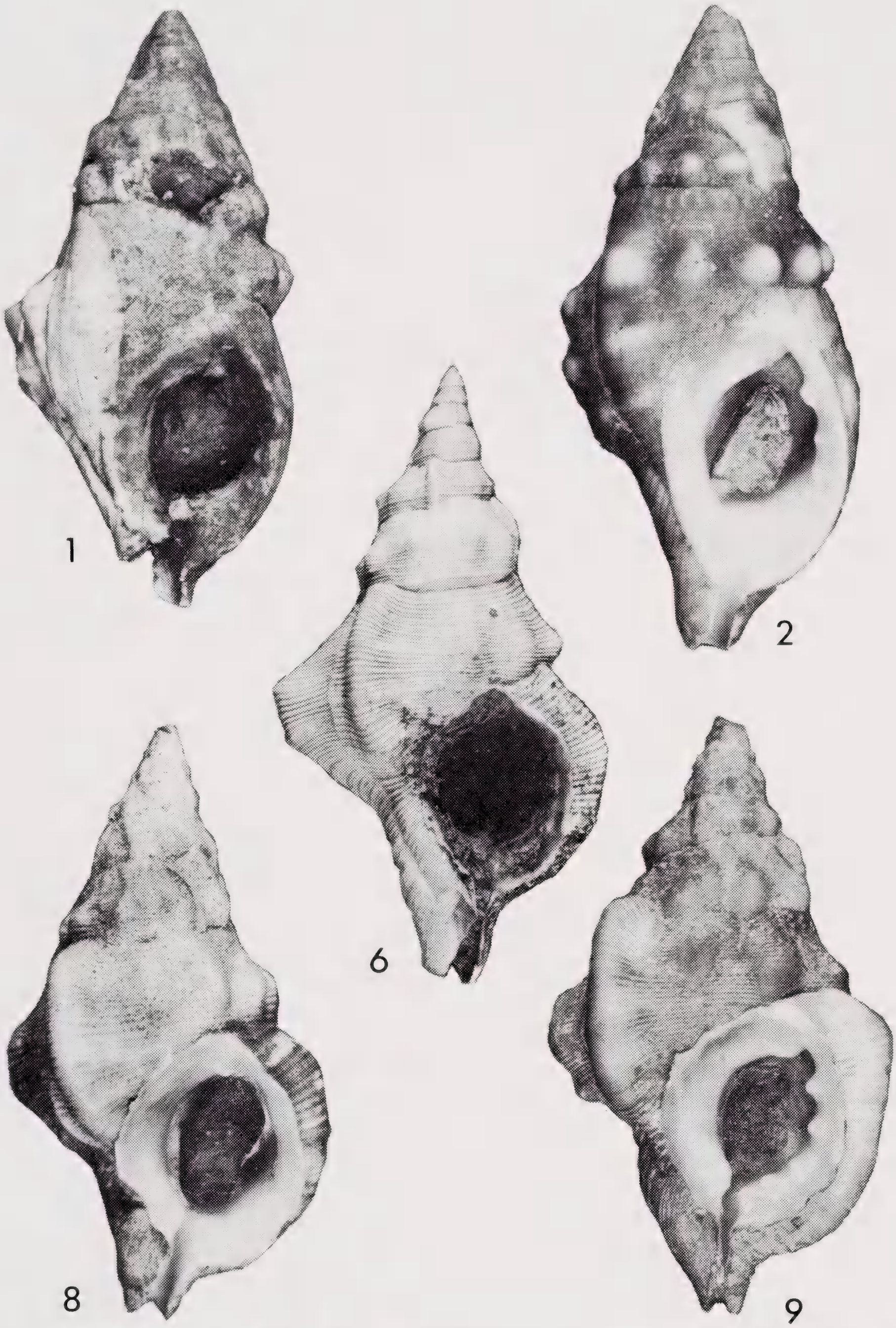


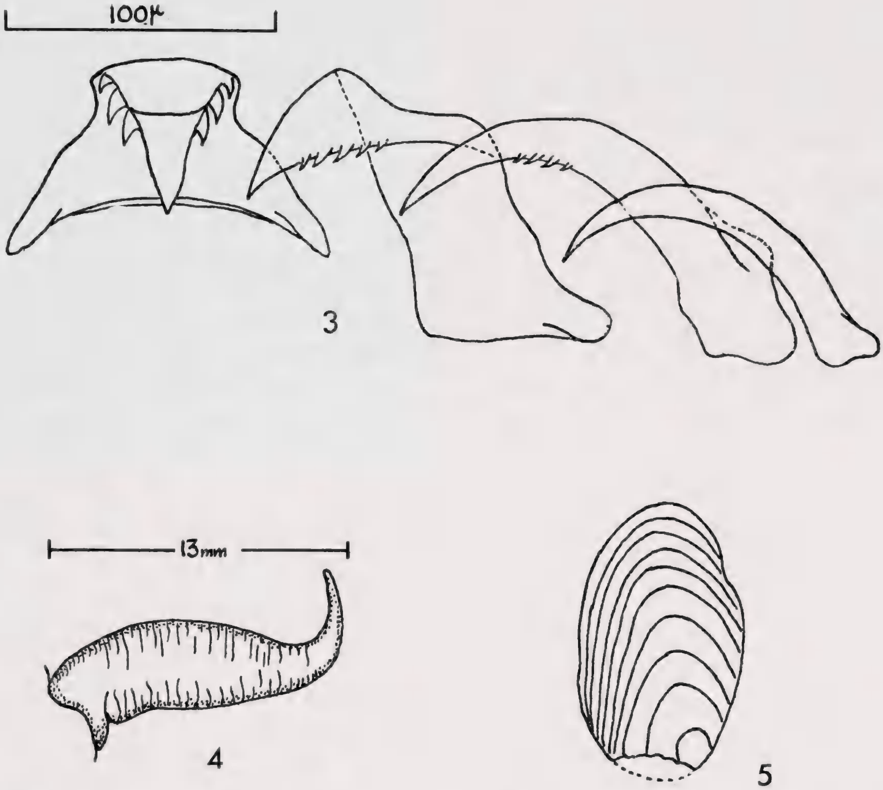
Fig. 1. *Proxicharonia arthritica* (Powell & Bartrum). Holotype Powell coll. No 3759, Auckl. Inst.Mus.; 50.0 x 26.0 mm. Oneroa, Waiheke I. (Awamoan), Lower Miocene.

Fig. 2. *Proxicharonia palmeri* Powell. Topotype from 17-20 fathoms, Poor Knights Islands; 50.3 x 23.3 mm.

Fig. 6. *Austrotriton woodsii* (Tate). Clifton beach, Princetown, Miocene of Victoria Australia. 36.4 x 19.6 mm.

Fig. 8. *Austrotriton parkinsonia* (Perry). Whangaroa Heads, N.I.; 38.5 x 21.0 mm.

Fig. 9. *A.parkinsonia* (Perry). Poor Knights Islands, 10 fathoms; 42.8 x 24.9 mm.



Figs. 3 - 5. *Proxicharonia palmeri* Powell. 3. Half-row of radula. 4. penis. 5. operculum.

appendages of *Cabestana, Mayena* and *Gyrineum,* but differs prominently from that of *Ranella.* The adult shell of *Proxicharonia palmeri* is orange-brown in colour with white round nodules; the labial lip has 8 prominent denticles, and the columella 15 smaller denticles which extend over the parietal wall to the anal notch; two of these denticles intrude on to the siphonal canal wall. The dimensions of the living specimen were: length 50.3 mm; width 23.3 mm; height of aperture 28.4 mm.

Genus Austrotriton Cossmann, 1903

Type-species (OD) *Triton radialis* Tate, 1888 (Miocene of Sth. Australia)

1903. (*Austrotriton*) Cossmann, Ess. paléoc.comp., 5:98
1931. *Austrosassia* Finlay, Trans.Proc.N.Z.Inst., 62(1):7 (Type-species OD *Septa parkinsonia* Perry, 1811)

When Finlay proposed *Austrosassia* for *Septa parkinsonia,* he segregated the Recent species from the Australian Miocene *radialis-woodsii* (Fig. 6) group of cymatids purely on features of the protoconch, despite the similarities of shell-characters in the two groups. He stressed that the only basis for the classification of the cymatids is the protoconch. Kesteven (1912), in his study of molluscan protoconchs, came to the conclusion that only those characters may safely be used for taxonomic purposes which reflect phylogenetic relationships; the protoconch in its

various forms having arisen from factors other than phylogenetic. It is true indeed that the protoconch will differ at times in the same species, particularly in specimens collected in shallow water of the intertidal zone and those from deeper water, as well as between juveniles and adults of the same species. The development of a species spawn is obviously affected by its environment, and may be retarded or accelerated in shallow or deeper water, with resulting changes in features of the protoconch. The number of liberated veligers, if few or many, is another contributing factor to the final shape of the protoconch in a species, particularly in the Volutidae. Since the type of protoconch tends to be variable in genera, sometimes in species, and also at different stages of development, it cannot be used indiscriminately to segregate species clearly belonging to the same genus-group on characters other than the protoconch. In families where species of the various genera have basically the same type of protoconch, an intrusion of a species with a radically different type of protoconch must be given due taxonomic consideration.

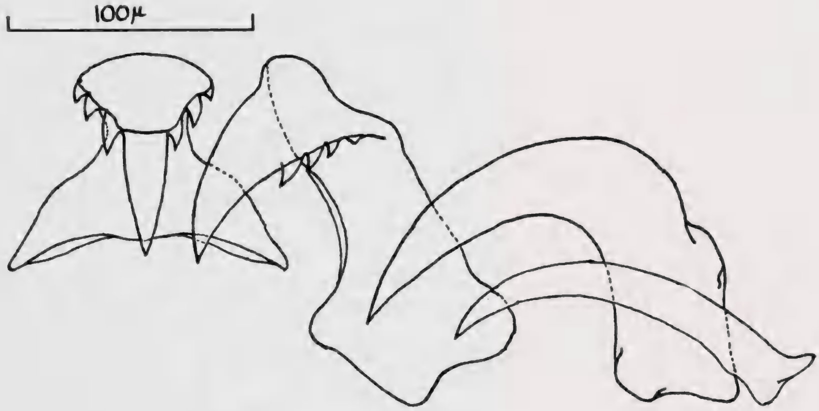


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Fig. 7. *Austrotriton parkinsonia* (Perry). Half-row of radula.

The radula of *Austrotriton parkinsonia* (Fig. 7) from the Poor Knights Islands, is basically of the same pattern as the radula of *Proxicharonia palmeri.* This type of radula lacks the concave excavations on the sides of the rhachidian of tropical cymatids. Specimens of *Austrotriton parkinsonia* (Figs. 8, 9) have been measured which equal in slenderness specimens of *Proxicharonia clifdenensis,* but also exceed the width ratio of *P.neozelanica.* When viewed from a ventral aspect, in species of *Proxicharonia* the outline of the body whorl extending from the presutural ramp to the siphonal fasciole is either moderately flat or slightly concave, but distinctly concave in *Austrotriton.* Species of *Austrotriton* and *Proxicharonia* are sculptured with numerous (40-70 on the body whorl) often finely beaded spiral threads. The aperture may be round, ovate or elliptical, and the siphonal canal straight or offset to the left, in species of both genera. A rather constant segregating feature is the flat, adpressed varices of *Proxicharonia* in contrast to the angulate varices of *Austrotriton.*

Some Austral-Neozelanic cymatid species presently assigned to *Austrotriton* or *Austrosassia,* closely resemble European species of *Sassia* Bellardi, 1873; the

resemblance to the English Eocene *Sassia expansa* (J. de C. Sowerby) and *S.arguta* (Solander), is very close indeed. The relationship of the European *Sassia* to the Austral-Neozelanic *Austrotriton* group remains to be elucidated.

The specific name *parkinsonia* is often found emended to "*parkinsoniana*" or "*parkinsonianum*" in cymatid literature. The specific name *parkinsonia* has been coined by Perry for J. Parkinson, and the termination of a taxon based on a personal name remains unchanged.

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EBALIA TUBERCULOSA (OXYSTOMATA:LEUCOSIIDAE); TWO FURTHER RECORDS FOR NEW ZEALAND WATERS

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Abstract. The recovery of two specimens of *Ebalia tuberculosa* (A. Milne-Edwards), from coastal trawl samples, is recorded.

Ebalia tuberculosa (A. Milne-Edwards) has been provisionally recorded in recent checklists of New Zealand Brachyura (Bennett 1964, p. 22; Dell 1968, p.22) based on its collection in these waters during the Challenger Expedition (Miers 1886, pp. 306-7; pl. 25, fig. 1). A record, by Chilton (1906, p. 266), has been dismissed by Bennett (1964, p. 22).

The discovery of a single female specimen owes its origin to the somewhat fortuitous collection of the very rare Ogcocephalid *Halieutaea maoria* (Powell) by an Auckland trawlerman, Mr. F. Yukich, in 60 - 80 fathoms (109.7 - 146.3 m) off the Aldermen Islands (26.iv.1967). This fish was subsequently offered to the Museum as an additional record.

Prior to preservation, I took the opportunity to examine stomach and gut content. The content was remarkable for its homogeneity of Ebalids, yielding five specimens of *Ebalia laevis* (Bell) and one *E. tuberculosa* (A. Milne-Edwards). All specimens were more or less undamaged, and digestive enzymes did not appear to have reduced features of diagnostic importance.

This female specimen of *Ebalia tuberculosa* (Fig. 1) generally agrees with the description and figure published by Hale (1927, p. 197; fig. 198). Carapace protuberances are less prominent, a feature noted for most New Zealand specimens examined by Miers (1886), and in Australian females by Whitelegge (1900, p. 161) and Rathbun (1923, p. 134; pl. 35, figs. 1-2). Posterior lobes are almost obsolete, a characteristic also recorded in previously collected New Zealand specimens by Miers. The carapace length is 7.6 mm and width 7.5 mm (c.f. Rathbun 1923, length of female E 5160 was 7.8 mm and width 7.7 mm). Overall body colour prior to preservation was pale cream. The tubercles were tinted orange, and there were pale orange blotchings over the frontal region and legs.

During recent prawn trials carried out aboard the trawler *Valkyrie,* a selection of benthic organisms were collected by Mr. C. Wormald, and distributed to various workers for identification and inclusion in reference collections. Subsequently, I have been given the opportunity to examine and report on a small male ebalid collected in 180-240 fathoms (329.2 - 438.9 m) east of the Poor Knights Islands (May 1969) which has also proved to be *E. tuberculosa.*

Rec. Auckland Inst. Mus. 7: 193-195 March 31st 1970

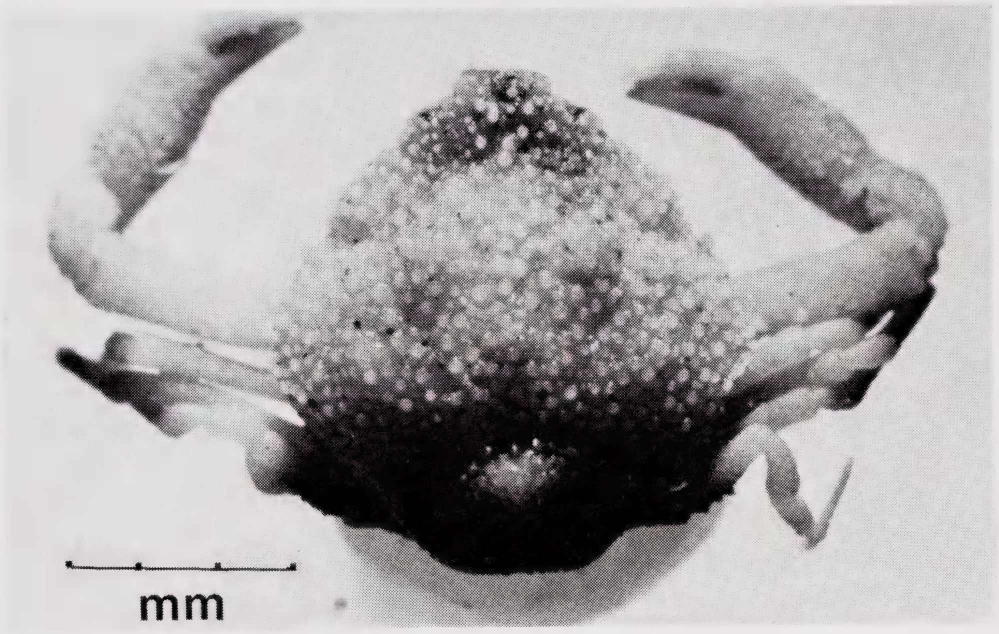

Fig. 1. *Ebalia tuberculosa.* Dorsal view, female.

In comparing it with the above female specimen, the branchial protuberances and posterior lobes appear relatively more prominent, as noted by previous workers. Carapace length (5.0 mm) is equidistant to width. Colour following alcohol preservation is pale cream.

Acknowledgements. I wish to acknowledge the friendly advice of Dr. J. C. Yaldwyn, Dominion Museum, who gave permission for me to report on the specimen from his *Valkyrie* collection. Thanks are also due to Dr. D. J. G. Griffin, Australian Museum, for checking my specimens with Australian material, and Mr. J. C. Darby, Otago Museum, for the use of comparative material.

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SOME NEW RECORDS OF FISH IN NEW ZEALAND WATERS

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Abstract. Seven fish species are recorded for the first time in New Zealand coastal waters.

Underwater diving techniques are fulfilling an increasingly important role in marine studies below the inter-tidal zone. Whereas we were once limited to the probing of grabs, nets and lines in exploration, collecting and recording, this new personalized sampling has produced a means through which we can rapidly challenge our previous knowledge of species occurrence and distribution.

The following new fish records have been obtained during underwater collections from the Poor Knight Islands and the north-eastern coastal waters of the North Island. Specimens are held in this Museum.

Family EPINEPHELIDAE

Aulacocephalus temmincki Bleeker

Aulacocephalus temmincki Bleeker, 1853, *Verh. Bat. Gen.* 25 : 10

D. IX 12, A. III 9, Ll. 73

Material examined. Poor Knights Islands: Northern Arch, speared at 130 ft. (39.62 m), (1), 4.V.1968, R. Bruce.

While recording its presence in the fauna of the Kermadec Islands, Waite (1911, p. 29) noted that "the locality represents its most southerly known range". In a later publication, Smith (1950, p. 190) wrote of its distribution as far south as Durban, which is approximately the same latitude as the Kermadec Group (30° S.). This record now extends the known southerly distribution of the species to latitude 35° 30′ S.

The inclusion of this species in a Checklist of New Zealand Fishes, by Whitley (1968b, p. 54) is based only on evidence of a news item (Doak & Tarlton 1968, p. 7).

Identification. From description of Boulenger (1895, p. 158) and in Smith (1950, pl. 16, fig. 419).

Previous localities. Widespread throughout central Indo-Pacific waters.

Rec. Auckland Inst. Mus. 7: 197-200 March 31st 1970

Acanthistius cinctus (Gunther)

Plectropoma cinctum Gunther, 1859, *Cat. Fish Brit. Mus.* 1 : 162

D. XIII 15, A. III 8, Ll. 60

Material examined. Poor Knights Islands: Northern Arch, speared at 150 ft. (45.72 m) (1), 19.1.1969, A. Ayling. Matauri Bay, Northland, at 40 ft. (12.19 m) (1), 6.IV.1969, J. Thornbury.

Identification. From description of Gunther (1859, pl. 162) and figure of type by Boulenger (1895, pl. 1).

Colouration. Overall body colour of live specimen is a pale yellow-brown rather than reddish-brown described by Gunther (1859, pl. 162) and divers commonly refer to this fish as a yellow banded perch. Overlying dark cross bands and stripes agree with the description.

Previous localities. Norfolk Island (type loc.), Lord Howe and Kermadec Islands.

Trachypoma macracanthus Gunther

Trachypoma macracanthus Gunther, 1859, *Cat. Fish Brit. Mus.* 1 : 167

D. XII 13, A. III 6, Ll. 50.

Attention to this fish was first drawn by an unidentified photograph (Doak 1969, p. 11).

Material examined. Poor Knights Islands: Hope Point (1), 23.III.1969, A. Ayling.

Identification. From description and drawing of Boulenger (1895, p. 146, pl. 2).

Colouration. In a fresh specimen the body has a crimson hue, which is noticeably paler along the belly. Spots have a pale blue centre with a dark brown circlet. The crimson colouration is replaced by brown tonings (cf. Boulenger 1895, p. 146) after preservation in alcohol.

Previous localities. From Norfolk Island (type loc.), Lord Howe and Kermadec Islands.

Family LABRIDAE

Pseudolabrus inscriptus (Richardson)

Labrus inscriptus Richardson, 1848, *Zool. Voy. Erebus and Terror Fish.* p. 134, pl. 56, fig. 1-2.

D. IX 14, A. III, 10.

Material examined. Poor Knights Islands: speared amongst seaweed at 30 ft. and 40 ft., 27.IV.1968 (9.14 m) (1), K. Tarlton (12.19 m) (1), D. Quinlan. Divers have since reported that this fish is of frequent occurrence and specimens have been collected as far south as the Whangaparaoa Peninsula, Hauraki Gulf (10.III.1969, B. J. Dunn).

Identification. From description and drawing of Richardson (1848, p. 134, pl. 56, figs. 1-2).

Previous localities. Norfolk Island (type loc.), Lord Howe and Kermadec Islands.

Pseudolabrus luculentus (Richardson)

Labrus luculentus Richardson, 1848, *Zool. Voy. Erebus and Terror, Fish.* p. 130.

D. IX II, A. III 10, Ll. 25.

Material examined. Poor Knights Islands: Southern cave (1), 25.III.1969, A. Ayling; Northern Arch, speared at 20 ft. (6.09 m) (1), 11.V.1969, B. Russell.

Identification. From notes and drawing of Waite (1903, p. 29, pl. V, fig. 1).

Previous localities. Norfolk Island (type loc.), Lord Howe and Kermadec Islands, Eastern and Western Australia.

Coris picta (Bloch and Schneider)

Labrus pictus Bloch and Schneider, 1801, *Systema Ichthyologiae.* p. 251, pl. 55.

D. IX 12, A. III 12, Ll. 83.

Material examined. Southern cave, speared at 40 ft. (12.19 m) (1), 25.II.1969, A. Ayling. Specimens have been examined from waters as far south as Hahei, Coromandel (8.III.1969, A. Ayling).

The darkly coloured comb-shaped bands on the sides of these fishes, which Whitley (1931, p. 323) regarded as "sufficient to distinguish this species generically from all other species allied to *Coris* Lacépède known to the writer", seem to be variable on New Zealand specimens to the extent that Whitley's genus *Ctenocorissa* warrants further investigation.

Identification. From drawing and description of Waite (1903, p. 26-27, pl. 5, fig. 1).

Previous localities. South Queensland, New South Wales, Lord Howe Island.

Family CANTHIGASTERIDAE

Canthigaster callisternus (Ogilby)

Tetrodon callisternus Ogilby, 1889, *Mem. Aust. Mus.* 2 : 74, pl. 3, fig. 5

D. I 10, A. I 9.

Material examined. Poor Knights Islands: Hope Pt., speared at 60 ft. (18.28 m) (2), 23.III.1969, A. Ayling.

Previous reports of this species occurring in the same locality, listed by Whitley (1968a, p. 40), are based on news items.

Identification. From description and drawing of Ogilby (1889, p. 74, pl. 3, fig. 5).

Previous localities. Lord Howe Island (type loc.), Kermadec Islands and Queensland.

DISCUSSION

Tropical Indo-Pacific elements of northern coastal faunas have been recognised for some time and these new records are of species of similar origin. Because of the previous lack of collecting by diving, it would be difficult to determine whether these fishes are recent arrivals or have remained undiscovered because of previous inadequacies of the sampling technique. In the case of two species, *Aulacocephalus temmincki* and *Trachypoma macracanthus,* there are grounds for suggesting their recent arrival because the frequency of underwater sightings of these fish, at this stage, is extremely low. Nevertheless, the certainty of such a suggestion lies in the continued involvement with underwater divers in observations and recording.

ACKNOWLEDGEMENTS. I gratefully acknowledge the assistance of underwater divers responsible for these collections, and Mr. J. Moreland, Dominion Museum, for his friendly advice.

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TRICHOPTERA OF NEW ZEALAND

II. The present status of R. J. Tillyard's species of New Zealand Trichoptera, with notes on the type specimens.

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Abstract. Type specimens, from New Zealand and Chatham Islands, of species described by R. J. Tillyard, are identified, recorded, and redescribed when necessary. *Helicopsyche howesi* Till. is confirmed as a separate species; the genus *Triplectidina* Mosely is redescribed on the basis of characters of the type species, *T. oreolimnetes* (Till.); two forms are recognised in the ♂ genitalia of *Dolophilodes* (*Hydrobiosella*) *stenocerca* (Till.); *Hydrobiosis lindsayi* Till. is re-established as a valid species; and *Synchorema zelandica* Mosely is synonymised with *S. zygoneura* Till.

Dr. R. J. Tillyard published two papers on the Trichoptera of New Zealand (1921, 1924) and one on the Chatham Islands fauna (1925). Species which he described in these papers are listed here in their correct taxonomic category, according to present-day knowledge. The type specimens are listed as designated by Tillyard, followed by the collecting data from labels on the specimens. Additional notes are given where required. Specimens and/or species and genera are described or discussed where necessary.

As much work as is thought worthwhile, for the present, has been carried out on Tillyard's types. It is not suggested that this paper completes the work to be done on his type specimens. As species become better known and genera are revised in the future, these specimens, particularly females, will still need to be examined.

Holotypes and allotypes were labelled as such or as 'Type' by Tillyard, but apparently he did not label paratypes. In his 1924 paper, in paragraphs headed "*Types*", he sometimes designated paratypes and sometimes mentioned series and specimens without designating them paratypes. Only where they are actually designated as paratypes by Tillyard, has the present author endeavoured to recognise specimens, as paratypes, in the original Cawthron Institute collection.

Specimens described by Tillyard in 1921 are in the G. V. Hudson collection, which is now in the Dominion Museum (D.M.), Wellington, N.Z.; those recorded in 1924 are all noted as being in the Cawthron Institute collection, which is now incorporated in the collections of the Entomology Division (E.D.), Department of Scientific & Industrial Research, Nelson, N.Z., but some of these specimens were apparently retained by Tillyard and, after his death, his Trichoptera collection was presented to the British Museum (Nat. Hist.) (Riley, in Preface to Mosely & Kimmins, 1953). Specimens now in the British Museum (Natural History) (B.M.N.H.), London, England, are also recorded. The three specimens Tillyard described in 1925 are in the Canterbury Museum (C.M.), Christchurch, N.Z.

Rec. Auckland Inst. Mus. 7: 201-215 March 31st 1970

Family SERICOSTOMATIDAE

Genus PYCNOCENTRIA McLachlan, 1866

Pycnocentria evecta McLachlan, 1868

Pycnocentria evecta McLachlan, 1868, *J. Linn. Soc. Lond. Zool.* 10: 199-200.
Pycnocentrodes chiltoni Tillyard, 1924, *Trans. N.Z. Inst.* 55: 309 (*partim,* allotype ♀).

Pycnocentrodes chiltoni allotype ♀ (E.D.)—"Nelson, N.Z., 29.11.20, A. Philpott". Genitalia in alcohol.

This ♀ specimen, which is not from the type locality of *chiltoni,* is now determined as *P. evecta* on characters of the wing venation and genitalia (see *Pycnocentrodes chiltoni* below).

Genus PYCNOCENTRODES Tillyard, 1924

Pycnocentrodes chiltoni Tillyard, 1924

Pycnocentrodes chiltoni Tillyard, 1924, *Trans. N.Z. Inst.* 55: 309.

Holotype ♂ (E.D.)—"Cass. N.Z., 6.1.20", (R. J. Tillyard holograph).

Allotype ♀ (E.D.)—not this species, see *Pycnocentria evecta* above.

3 Paratype ♂♂ recorded from Cass — 1 ♂ (E.D.), "Cass, N.Z. 6.1.20" (R. J. Tillyard holograph), now recognised and labelled as paratype ♂.

3 Paratype ♀♀, 1 paratype ♂, recorded from Nelson—the 3 ♀♀ cannot be recognised in the original collection. There are 3 ♂♂ from Nelson, collected by A. Philpott in 1920, which were all placed in this species in the original Cawthron Institute collection, but all three are without abdomens. It seems pointless to choose any one of these three as a paratype.

In *Pycnocentrodes* there appears to be either a very variable species or a species complex, the species of which are not necessarily characterised by the type specimens chosen by McLachlan (*aureola* McL., 1868), Tillyard (*chiltoni* Till., 1924, *pulchella* Till., 1924) or Wise (*aeris* Wise, 1958, *unicolor* Wise, 1958). Throughout this group there are marked variations, in the males, in size, wing colour, wing pattern, venation and in the genitalia. The ♂ genitalia are different in detail from specimen to specimen while wing colour and pattern appear to range from the palest and least pronounced in *aeris* Wise to the brightest and most pronounced in *pulchella* Tillyard. The genus needs a revision based on large numbers of specimens from many different localities, and until this is done the present author is determining species on general appearance, *P. chiltoni* being separated from *aureola* (= *pulchella*) by the terms of Mosely & Kimmins' (1953) key.

Female specimens, at present recognised as *P. chiltoni* by the present author, have wing venation as figured by Mosely & Kimmins (1953) for *P. aureola,* but wing pattern and mostly silver-white dorsal hairs on the head, as on *chiltoni* males (not ginger to black dorsal hairs on the head as in *aureola*), separate them from

aureola females. The genitalia of ♀ specimens presumed to be *chiltoni* vary from the figure of *aureola* ♀ genitalia, by Mosely & Kimmins (1953), in having a median notch in the medial dorsal lobe, instead of a small median projection.

Pycnocentrodes aureola (McLachlan, 1868)

Pycnocentria aureola McLachlan, 1868, *J. Linn. Soc. Lond. Zool.* 10: 200.
Pycnocentrodes pulchella Tillyard, 1924, *Trans. N.Z. Inst.* 55: 310.

Pycnocentrodes pulchella holotype ♂ (E.D.)—"Lumsden, N.Z., 13.12.19" (R. J. Tillyard holograph).

3 Paratype ♂ ♂ — 1 ♂ (E.D.), "Lumsden, N.Z., 13.12.19", (R. J. Tillyard holograph), now recognised and labelled as paratype ♂. 2 ♂ ♂ (B.M.N.H.), bearing the same data labels, have already been recognised and labelled as paratypes by the late M. E. Mosely.

Mosely & Kimmins (1953:85) mentioned a paratype of *pulchella* in the British Museum (Nat. Hist.) collections and synonymised *pulchella* with *aureola* McL.

The holotype specimen has a dorsal median pair of asymmetric pointed projections, on the ninth segment between the superior appendages, where only one is figured and described for *aureola* by Mosely & Kimmins (1953). For the time being (for the reasons given above under *P. chiltoni*), these projections on this specimen are considered to be aberrations and *pulchella* is accepted as a synonym of *aureola*.

Genus CONFLUENS Wise, 1962

Confluens olingoides (Tillyard, 1924)

Pycnocentrodes olingoides Tillyard, 1924, *Trans. N.Z. Inst.* 55: 130.

Holotype ♂ (E.D.) —"Gouland Downs, 7 Feb. 1922, R. J. Tillyard".

Allotype ♀ (E.D.) — data as for holotype.

Paratype ♂ recorded from same locality — no such specimen in the E.D. or B.M.N.H. collections.

The genus and the two species therein have been redescribed by McFarlane (1966).

Confluens hamiltoni (Tillyard, 1924)

Pycnocentrodes hamiltoni Tillyard, 1924, *Trans. N.Z. Inst.* 55: 311.

Holotype ♂ (E.D.) —"Tokaanu, N.Z., P.27.11.19" (R. J. Tillyard holograph).

Allotype ♀ (E.D.) — data as for holotype.

Tillyard (1924) recorded the locality as "Poutu River, between Tokaanu and Lake Roto-Aira, North Island . . .".

Genus Helicopsyche Hagen, 1866

Helicopsyche albescens Tillyard, 1924

Helicopsyche albescens Tillyard, 1924, *Trans. N.Z. Inst.* 55: 312.

Holotype ♂ (E.D.) —"Purau, N.Z., 3.1.20" (R. J. Tillyard holograph).

Allotype ♀ (E.D.) — data as for holotype. This specimen is a male, so has been recognised and labelled as a paratype ♂ by the present author.

Paratype ♂ ♂ — 2 ♂ ♂ (E.D.) (1 damaged) on one pin, same data as holotype, are now recognised and labelled as paratype ♂ ♂. 2 ♂ ♂ (B.M.N.H.) "Purau Creek, Lyttelton Harbour, 3.1.1920, R.J.T.", recognised and labelled as paratypes by Mosely.

Recorded by Tillyard (1924) from "Purau Creek, Lyttelton Harbour . . .".

Helicopsyche howesi Tillyard, 1924 (Figs. 1 - 4)

Helicopsyche howesi Tillyard, 1924, *Trans. N.Z. Inst.* 55: 213.

Holotype ♂ (E.D. — "Dunedin, bred 1.1.20" (R. J. Tillyard holograph). Genitalia now in alcohol.

Description of holotype.

A pale species as described by Tillyard (1924), similar in appearance to *H. albescens* but larger. Venation (Fig. 1) similar to other species in genus but differing noticeably from other New Zealand species in posterior wing where fork 1 is distinctly longer than its footstalk. Genitalia, ♂ (Figs. 2, 3, 4). Segment X flattened, with an apical median incision and a reflexed upright tooth on each side. Superior appendages short, expanded distally. Inferior appendages bifid; dorsal branch with a long posterior extension, ventral branch long and straight in lateral view, basally with an internal setose projection possibly representing a third branch. Aedeagus basally with a short sharp lateral spine on each side, apically with two rounded dorsal lobes, each with a median chitinised pointed structure, and with a dorso-lateral point on each side; an elongate eversible sac which encloses a chitinous ring towards distal end.

This species is separated from other New Zealand species by the above-mentioned character of fork 1 in the posterior wing and in the form of the ♂ genitalia. The latter are apparently similar to the genitalia of *H. poutini* McFarlane, 1964, but that is a small black species.

Tribe OECONESINI Tillyard, 1921

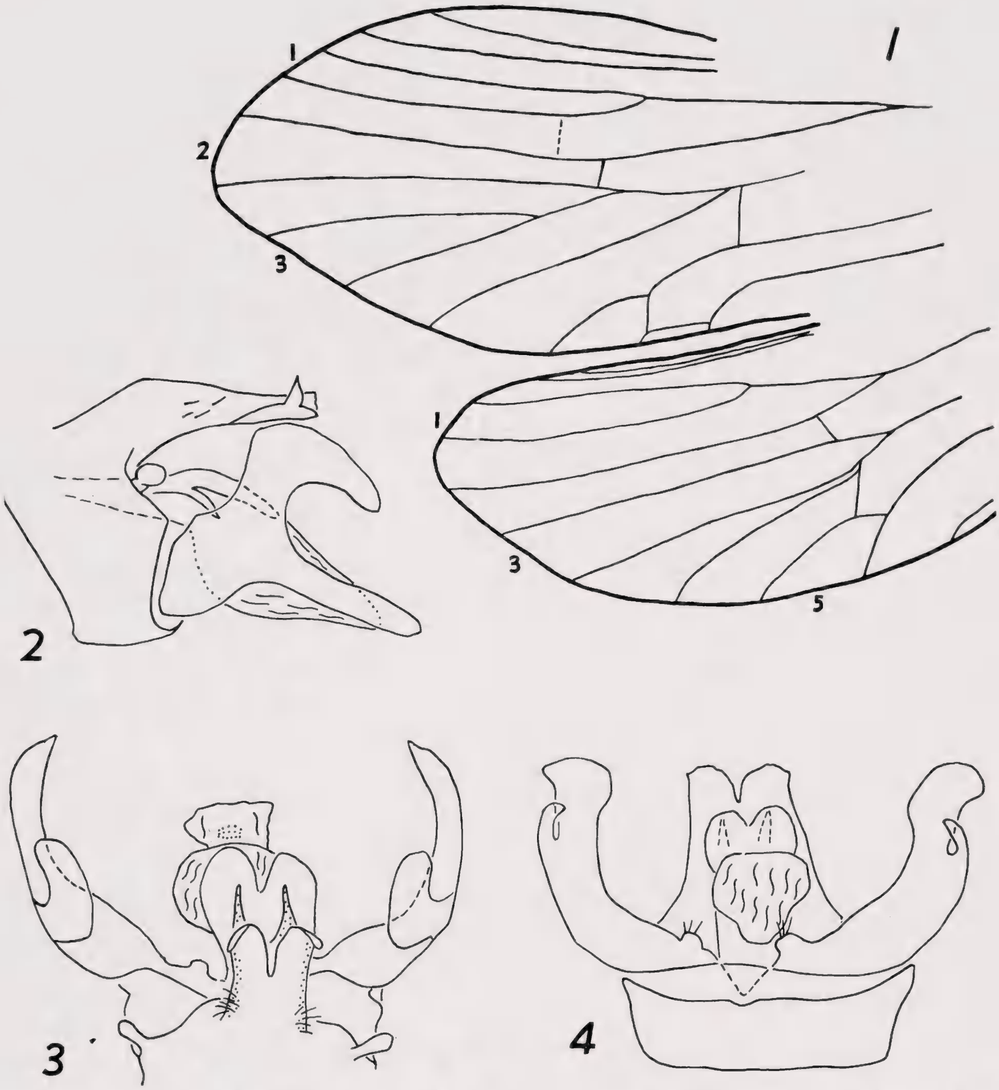
Genus Zelandopsyche Tillyard, 1921

Zelandopsyche ingens Tillyard, 1921

Zelandopsyche ingens Tillyard, 1921, *Trans. N.Z. Inst.* 53: 349.

Holotype ♂ (D.M.) —"100a" (G. V. Hudson holograph). Hudson's register reads, "100a. Captured amongst stones at the waters edge Routeburn river Lake Wakatipu close to the hut Feb. 8 & 10, 1911".

Allotype ♀ (D.M.) — label and data as for holotype.



Figs. 1-4. *Helicopsyche howesi* Till. 1. Wings. 2. ♂ genitalia, lateral. 3. ♂ genitalia, dorsal. 4. ♂ genitalia, ventral.

Family PHILANISIDAE

Genus CHATHAMIA Tillyard, 1925

Chathamia brevipennis Tillyard, 1925

Chathamia brevipennis Tillyard, 1925, *Rec. Cant. Mus.* 2: 280 (Rhyacophilidae).

Holotype ♂ (C.M.) —"Kaingaroa 25 Dec. 1923". Recorded by Tillyard (1925) as collected by C. Lindsay. In poor condition, head capsule and abdomen on micro-slide marked holotype.

C. brevipennis was transferred from the Rhyacophilidae to the Philanisidae by Wise (1965), and the subfamily Chathamiinae, which Tillyard erected in the family Rhyacophilidae, is probably not now required as the species is obviously a derivative of the australasian *Philanisus plebeius,* the only other species in the family.

Family PHILORHEITHRIDAE

Genus PHILORHEITHRUS Hare, 1910

Philorheithrus lacustris Tillyard, 1924 (Figs. 5, 6)

Philorheithrus lacustris Tillyard, 1924, *Trans. N.Z. Inst.* 55: 305 (Calamoceratidae).

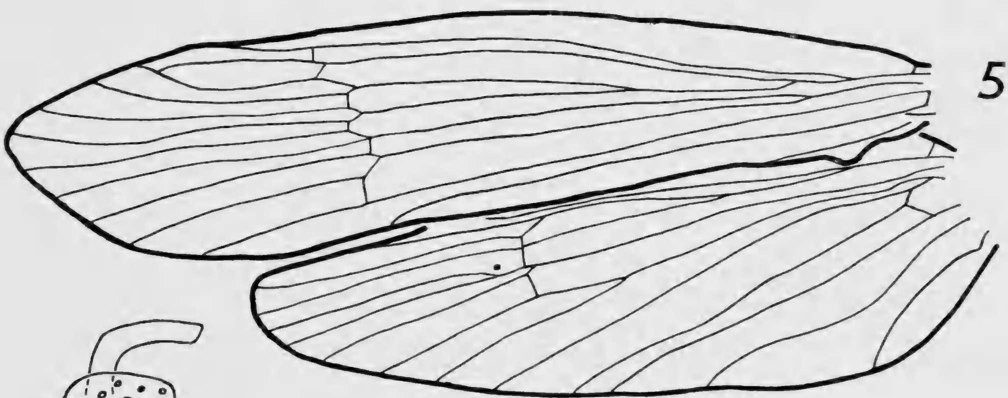
Holotype ♂ (E.D.) —"Kingston, N.Z., 13.12.19" (R. J. Tillyard holograph). Abdomen now in alcohol.

Paratype ♂♂ — there are no specimens from this type locality in the original Cawthron Institute collection. 1 ♂ (B.M.N.H.) with the same label as holotype, abdomen missing.

At the time of describing this species, Tillyard (1924) placed the genus in the family Calamoceratidae but it has since been transferred to the Philorheithridae by Mosely (1936a).

In general appearance, the holotype is as described by Tillyard (1924). Wings are as figured (Fig. 5), while Kimmins (Mosely & Kimmins, 1953) has already noted the presence of some broad hairs on the posterior wing.

The genitalia of the ♂ holotype are very similar in general appearance to those of *P. agilis* as figured by McFarlane (1966) and Mosely & Kimmins (1953).



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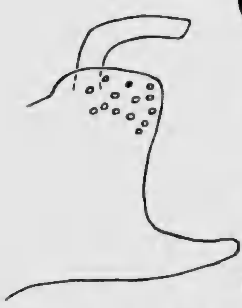

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Figs. 5, 6. *Philorheithrus lacustris* Till. 5. Wings. 6. ♂ genitalia, inferior appendage.

McFarlane (1966) has already pointed out that the figure named as *agilis* by Mosely & Kimmins (1953) is not that species and that it is similar to *lacustris*. The obvious point of difference between *agilis* and *locustris* is the shape of the internal upper branch of the inferior appendage, which is straight and dilated distally in the former, but is narrow, angled posteriorly and slightly tapering (Fig. 6) in the latter.

Family LEPTOCERIDAE

Genus TRIPLECTIDINA Mosely, 1936

This genus cannot be characterised as it has been in the past as the main points, used for its separation, have been in error.

Following examination of the type specimens, and others, of the type species *Triplectides oreolimnetes* Tillyard, 1924, the genus is distinguished as follows.

Anterior wing with apical forks 1 and 5 present in male (Fig. 7); 1, 3, and 5 in female. Discoidal cell longer than its footstalk; only a slightly posteriad extension of posterior distal angle, if at all; cross-vein straight or only slightly concave; posterior margin not thickened (Fig. 8). Thyridial cell present, shorter than discoidal cell in male; margins not thickened. Posterior wing (Fig. 7) with forks 1, 3, and 5 present in both sexes; fork 1 shorter than its footstalk. Genitalia, ♂, of *Triplectides* pattern, inferior appendages three-branched. Tibial spurs 2:2:4.

The anterior wing tends to fold between Rs and M, particularly between the discoidal and thyridial cells, but the fold is not permanent and the thyridial cell can be seen on wings *in situ* in some specimens. This fold has possibly given rise to the mistaken impression that parts of the veins are thickened, as was stated in the original description of the genus.

Following discovery of the thyridial cell in the forewing, the type species traces to the genus *Hudsonema* Mosely in keys by Mosely (1936b), Mosely & Kimmins (1953). However, it is considered that *Triplectidina* is a valid genus separated from *Hudsonema* and *Triplectides* by the length of the discoidal cell, in the anterior wing, which is longer than its footstalk; in the male this cell is also longer than the thyridial cell. This genus is further separated from *Hudsonema* and other genera of the subfamily (except *Triplectides*), by the character of fork 1, in the posterior wing, which is usually present and is shorter than its footstalk.

Triplectidina nigricornis Mosely has not been examined in the present study and it is not known if this species should still belong to the genus.

Triplectidina oreolimnetes (Tillyard, 1924) (Figs. 7, 8)

Triplectides oreolimnetes Tillyard, 1924, *Trans. N.Z. Inst.* 55: 306.

Holotype ♂ (E.D.) —"Gouland Downs, 7 Feb. 1922, R. J. Tillyard". Tillyard (1924) added the altitude, "2000ft.".

Allotype ♀ (E.D.) — as holotype.

7 Paratype ♂♂ — 2♂♂ (E.D.), as holotype, now recognised and labelled as paratypes. Genitalia of one paratype now in alcohol. 1♂ (B.M.N.H.) with data as holotype, previously recognised and labelled as a paratype by Mosely.

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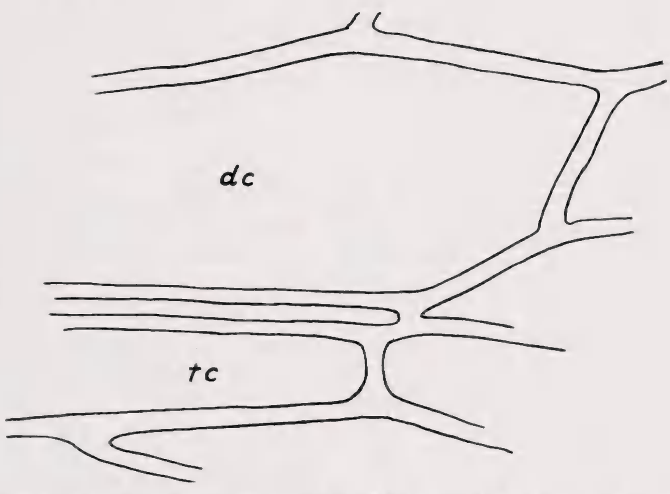

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Figs. 7, 8. *Triplectidina oreolimnetes* (Till.). 7. Wings. 8. Anterior wing, detail of discoidal cell (dc)—thyridial cell (tc) area.

This species is as described, by Tillyard (1924), in general appearance. Wing venation of males (Figs. 7, 8) is as in generic diagnosis above, not entirely as described by Mosely (1936b), Mosely & Kimmins (1953). In a few males, from one locality, fork 1 of the posterior wing is aberrantly absent, one specimen also has an aberration of fork 5, but in other respects, including genitalia, these specimens have the characters of this species. Venation of the allotype ♀ is similar to the description and figure by McFarlane (1966) except in the configuration of the discoidal cell, of the anterior wing, which is a little wider with the cross-vein longer and angled as in the male. The paratype ♂, and other specimens, have genitalia as

figured by Mosely & Kimmins (1953) except that the paratype has an aberration in the mid-dorsal processes where one is twice as long as the other. McFarlane (1966) has figured the ♀ genitalia.

Genus OECETIS McLachlan, 1877

Oecetis chathamensis Tillyard, 1925

Oecetis chathamensis Tillyard, 1925, *Rec. Cant. Mus.* 2: 283.

Holotype ♂ (C.M.) —"The Ngaio, Chatham I., 24 Jan. 1924, C. Lindsay". In poor condition, abdomen missing, one pair of wings on micro-slide marked holotype.

Family HYDROPSYCHIDAE

Genus HYDROPSYCHE Pictet, 1834

Hydropsyche philpotti Tillyard, 1924

Hydropsyche philpotti Tillyard, 1924, *Trans. N.Z. Inst.* 55: 301.

Holotype ♂ (E.D.) —"Dun Mt. 3000′, 8.1.22. A. Philpott."

3 Paratype ♂ ♂ — 2 specimens (E.D.) in the original Cawthron Institute collection, as holotype. Although one is without abdomen, both are recognised and labelled as paratype ♂ ♂ by the present author. 1 ♂ (B.M.N.H.) with data as holotype, previously recognised and labelled as a paratype by Mosely.

Wing venation much as figured, by Mosely & Kimmins (1953) for this species under the name of *Cheumatopsyche philpotti,* except that fork 1 of the anterior wing is stalked. the stalk varying in length between specimens. McFarlane (1960) recorded *Hydropsyche philpotti* mentioning the stalked fork 1, while Kimmins (1960) also corrected the generic placing, based on the wing venation.

Male genitalia are as figured and described by Mosely & Kimmins (1953) although their figures of the aedeagus show the apex somewhat flattened. McFarlane (1960) mentioned that the finger-like processes of segment X may be more or less inwardly turned, which is the case in the holotype and one paratype recorded above (E.D.).

Family PSYCHOMYIIDAE

Genus ZELANDOPTILA Tillyard, 1924

As described for *Zelomyia* McFarlane, 1956, which is synonymous.

Zelandoptila moselyi Tillyard, 1924

Zelandoptila moselyi Tillyard, 1924, *Trans. N.Z. Inst.* 55: 301 (Hydroptilidae).

Holotype ♀ (E.D.) —"Tokaanu, N.Z. 24.11.19" (R. J. Tillyard holograph). Ovipositor broken.

McFarlane recognised *Zelomyia trulla* McFarlane, 1956 (Psychomyiidae), as being conspecific with this type specimen and consequently (1964) recorded the synonymy, at the same time transferring *Zelandoptila* to the family Psychomyiidae.

Wing venation of both sexes is as figured for the male by McFarlane (1956) except that the holotype has R_2 and R_3 as a single vein. Genitalia are also as figured (McFarlane, 1956).

Family PHILOPOTAMIDAE

Genus DOLOPHILODES Ulmer, 1909

Subgenus HYDROBIOSELLA Tillyard, 1924

Tillyard (1924) described *Hydrobiosella* as a genus of the family Rhyacophilidae with *H. stenocerca* Till., 1924, as the type species. Banks (1939) recorded the type species as *Philopotamus stenocerca* in the family Hydropsychidae, while McFarlane (1939) recorded *Hydrobiosella stenocerca* Till. in the family Philopotamidae, as did Mosely & Kimmins (1953). Ross (1956) reduced *Hydrobiosella* to a subgenus of *Sortosa* Navás, 1918, also recording *Dolophilodes* Ulmer, 1909, as another subgenus. However, as *Dolophilodes* predates *Sortosa,* the former should have been used as the generic name, as has since been recognised by Schmid (1964). Consequently, *Hydrobiosella* is now a subgenus of *Dolophilodes,* and the species name is as listed by Wise (1965).

Dolophilodes (Hydrobiosella) stenocerca (Tillyard, 1924) (Figs. 9, 10)

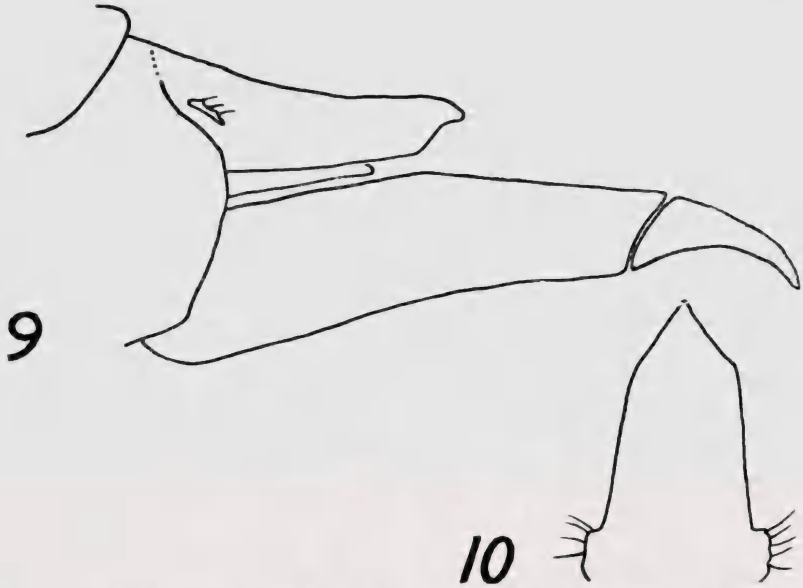
Hydrobiosella stenocerca Tillyard, 1924, *Trans. N.Z. Inst.* 55: 289 (Rhyacophilidae).

Holotype ♂ (E.D.) —"Gouland Downs, 7 Feb. 1922, R. J. Tillyard". Abdomen now in alcohol.

Allotype ♀ (E.D.) —"Nelson, N.Z., 29.12.20, A. Philpott".

The holotype ♂ is as described by Tillyard (1924). Wing shape and venation are as figured by Mosely & Kimmins (1953). The ♂ genitalia (Figs. 9, 10) are in the same pattern as figured by Mosely & Kimmins (1953) but vary in the shape of the dorsal plate (segment X) and the distal segment of the inferior appendage. The dorsal plate tapers only slightly and has distinct angles near the apex as seen in dorsal view (as figured by Tillyard, 1924); the distal segment of the inferior appendage is strongly concave beneath, giving the segment an arched appearance in lateral view. The holotype genitalia seem to represent a South Island form of the species, while the figures by Mosely & Kimmins (1953) may represent a predominantly North Island form. The latter could almost be recognised as a separate species, but one specimen in the Cawthron Institute collection, taken near Nelson in the South Island, is either the North Island form or an intermediate between the two forms.

The ♀ genitalia, of the allotype and other South Island females, are as figured by Mosely & Kimmins (1953) except that the end of the oviscapt (segment X) has a pair of cerci.



Figs. 9, 10. *Dolophilodes* (*Hydrobiosella*) *stenocerca* (Till.). 9. ♂ genitalia, lateral. 10. ♂ genitalia, dorsal plate.

Family RHYACOPHILIDAE

Genus Hydrobiosis McLachlan, 1868

Hydrobiosis lindsayi Tillyard, 1925

Hydrobiosis lindsayi Tillyard, 1925, *Rec. Cant. Mus.* 2: 277.

Holotype ♂ (C.M.) —"Chatham Is. 25 Jan. 1924, C. Lindsay". Poor condition, one pair of wings on a micro-slide marked holotype, ♂ genitalia has been destroyed.

McFarlane (1951b) synonymised *H. lindsayi* with *H. umbripennis* McL. However, when this paper was almost completed, Mr. McFarlane kindly wrote urgently to advise that some more-recent Chatham Islands specimens, just examined by him, are distinct from *H. umbripennis*, and the species *lindsayi* is valid.

Genus Synchorema Tillyard, 1924

Synchorema zygoneura Tillyard, 1924

Synchorema zygoneura Tillyard, 1924, *Trans. N.Z. Inst.* 55: 297.
Synchorema zelandica Mosely, 1953, *Trichoptera Australia & N.Z.* : 464. *syn. n.*

Holotype ♂ (E.D.) —"Mt. Arthur 4500ft. 23.12.21, A. Philpott". Specimen in poor condition with one forewing and one hindwing missing, abdomen now in alcohol.

Allotype ♀ (E.D.) —"Arthurs Pass, N.Z. 19.1.20" (R. J. Tillyard holograph). Tillyard (1924) recorded the altitude, "2800ft.". This specimen is a male, so is recognised and labelled as a paratype ♂ by the present author.

McFarlane (1964) has pointed out that the figure given by Tillyard (1924) for the male genitalia of *S. zygoneura* is not of this species, and he has figured both species involved, *zygoneura* and *tillyardi* McFarlane, 1964. Mosely & Kimmins (1953) had previously figured the ♂ genitalia of the species *S. zelandica* Mosely, 1953, which was based on a unique holotype collected at Queenstown on 14.12.1919 by Tillyard. Another specimen of *Synchorema,* taken at Queenstown by Tillyard on the same date, has now been recognised in the Cawthron Institute collection. The ♂ genitalia of this last specimen and of the holotype of *S. zygoneura* have now been prepared, compared, and found to be conspecific. They are definitely of the species figured as *S. zelandica* by Mosely & Kimmins (1953) and consequently it is considered that *zelandica* is a synonym of *zygoneura.*

The ventral surface of the aedeagus, in this species, is slightly more chitinised than the remainder and develops as two apical lobes on each side of a ventral median excision (see Mosely & Kimmins, 1953, McFarlane, 1964). It seems that, in the specimen figured by Mosely & Kimmins (1953), this ventral surface may have peeled ventrally at the apex, giving rise to the condition figured and named as "lower penis cover" by them.

Genus Neurochorema Tillyard, 1924

Neurochorema confusum (McLachlan, 1868) (Fig. 11)

Psilochorema confusum McLachlan, 1868, *J. Linn. Soc. Lond. Zool.* 10: 210.
Neurochorema decussatum Tillyard, 1924, *Trans. N.Z. Inst.* 55: 291.

Holotype ♂ (E.D.) —"Nelson, N.Z., 5.10.20, A. Philpott".

Allotype ♀ (E.D.) —"Nelson, N.Z., 20.10.20, A. Philpott".

5 Paratype ♂♂ — 5♂♂ (E.D.) previously determined as *Neurochorema decussatum* Till. in the Cawthron Institute collection, but without separate determination labels, were collected on "5.10.20", "2.10.20", "16.11.20", "5.10.20", "11.10.20", by A. Philpott at Nelson, which fits in with the recorded paratype data, ". . . taken October to November, 1920, by Mr. Philpott, at Nelson: . . .". These are considered to be the paratypes of *decussatum* and have now been so labelled. Three specimens are without abdomens.

McFarlane (1939, 1951a, 1964) has discussed this species and the genus in detail. He recorded (1964, p. 66) one character of the male forewing as "rc is not closed by a cross-vein", which is true for the *decussatum* holotype and other specimens (as figured by Tillyard, 1924), in what might be termed the primary position, that is at the spot where the cross-vein occurs in the female and as indicated (in error) for the male by Mosely & Kimmins (1953). However, amongst the *decussatum* paratypes there is one specimen in which R_3 combines with R_4 for a short distance, thus closing the radial cell, in one anterior wing, a condition which also occurs in the one remaining anterior wing of another paratype (Fig. 11) and in both anterior wings of one non-paratype specimen from the *decussatum* type locality; in a further paratype specimen the same condition occurs in the left anterior wing, while in the right wing R_3 and R_4 are only just apart at the same point. An aberrant and variable secondary closure of the radial cell in the anterior wing is thus shown to occur in this species.

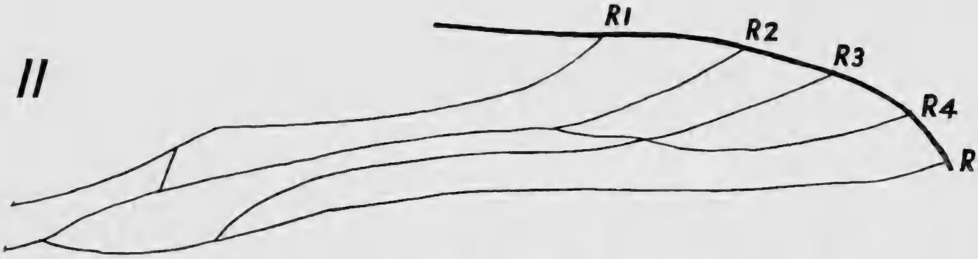


Fig. 11. *Neurochorema confusum* (McL.). Anterior wing of *N. decussatum* Till. paratype, radial veins.

Genus HYDROCHOREMA Tillyard, 1924

Hydrochorema crassicaudatum Tillyard, 1924

Hydrochorema crassicaudatum Tillyard, 1924, *Trans. N.Z. Inst.* 55: 293.

Holotype ♂ (E.D.)—"Nelson, N.Z., 15.12.21, A. Philpott".

Male genitalia are as figured and described by Mosely & Kimmins (1953) except for one character. *In situ,* the dorsal internal basal area of the inferior appendage, of the holotype and another specimen, appears as a moderately long lobe or branch rather than as a plate-like shelf as described and figured by Mosely & Kimmins (1953).

Hydrochorema tenuicaudatum Tillyard, 1924

Hydrochorema tenuicaudatum Tillyard, 1924, *Trans. N.Z. Inst.* 55: 295.

Holotype ♀ (E.D.) —"Mt. Arthur, 4500ft., 28.2.21, A. Philpott".

Allotype ♂ (E.D.) — label as holotype. Abdomen missing, removed by Tillyard. Right anterior wing and apical portion of left, missing.

This species is recognisable from the description and figures by Tillyard (1924). The genus *Hydrochorema* has been characterised from *H. crassicaudatum* by Tillyard (1924), Mosely & Kimmins (1953). *H. tenuicaudatum* is congeneric with that species but it should be noted that in some specimens, both males and females including the holotype ♀, fork 1 of the anterior wing is short-stalked. Individually, these specimens would trace to *Neurochorema* in the key to genera of Hydrobiosinae in Mosely & Kimmins (1953), but the very short stalk and the long, almost parallel sides of the fork differentiate them from specimens of that genus.

Genus TIPHOBIOSIS Tillyard, 1924

Tiphobiosis montana Tillyard, 1924

Tiphobiosis montana Tillyard, 1924, *Trans. N.Z. Inst.* 55: 299.

Holotype ♂ (E.D.) —"Ben Lomond 15/12/19" (date is R. J. Tillyard holograph). Tillyard recorded "Ben Lomond, Queenstown, 4000ft. (15th December, 1919, R.J.T.), . . .". Abdomen missing, unfortunately recently mislaid in transit.

Allotype ♀ — recorded by Tillyard (1924), "Gouland Downs, 2000ft., Nelson Province (7th February, 1922, R.J.T.) . . .". This specimen was taken so far from the holotype locality that there is no guarantee that it was correctly associated with the male. Entomology Division, Nelson, have advised that this allotype specimen was accidentally destroyed some time ago.

Paratype ♂ ♂ — several recorded by Tillyard (1924) as taken at the same time as the holotype. Two specimens (E.D.), both without abdomens, mounted on one pin, with the same data as holotype. These are now recognised and labelled as paratypes by the present author. 2 ♂ ♂ (B.M.N.H.) with same data as holotype, previously recognised and labelled as paratypes by Mosely.

There is one micro-slide (E.D.) of the ♂ genitalia of this species labelled *Tiphobiosis montana* Till., but it has no locality data and cannot be matched with any specimen in the collection.

Tiphobiosis fulva Tillyard, 1924

Tiphobiosis fulva Tillyard, 1924, *Trans. N.Z. Inst.* 55:300.

Holotype ♀ (E.D.) —"78a" (G. V. Hudson holograph). Hudson's register reads, "78a. Humboldt Range Lake Wakatipu March 2-03 near waterfall, 3600ft.".

Tillyard (1924) recorded the specimen as a female, having seen the abdomen before it was lost. It has not yet been possible to associate this specimen with any others to further determine the species.

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ON THE TERRESTRIAL INVERTEBRATE FAUNA OF WHITE ISLAND, NEW ZEALAND

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Abstract. White Island is a small active volcano off the east coast of the North Island, New Zealand. The active crater is barren but outer lower-slopes and the shore support a restricted flora and fauna of *Metrosideros* forest, bird colonies, and smaller animals and plants. 162 species of terrestrial invertebrates are listed; the fauna is found to be derived from the New Zealand mainland fauna. Associations in various localities and habitats are also listed and discussed. Leaf litter and other samples were catalogued in a 'Plant/soil samples' series and invertebrates extracted per cold and top-heated funnels; comparative results are discussed.

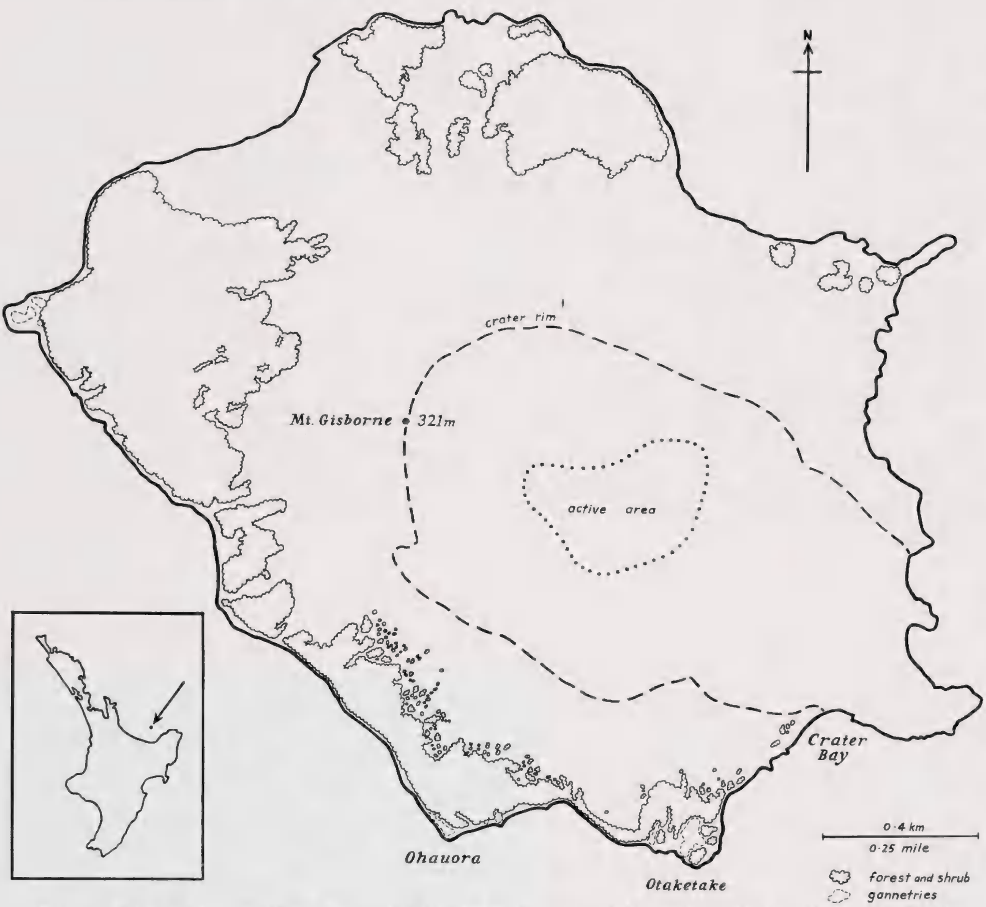


Fig. 1. White Island. (Based on N.Z.D.S.I.R. Map, 1957). Insert shows North I., N.Z., with position of White I. (arrowed).

White Island is an active volcano (Fig. 1) lying off the eastern coast of the North Island, New Zealand, in the Bay of Plenty, 48-96 km (30-60 miles) north and east of the adjacent coast. The island is more or less circular, *ca.* 2 km (*ca.* 1.25 miles) in diameter with a nearly central active volcanic crater (Fig. 2). The crater walls, which are up to 321 m (1053 ft.) above sea level, are breached on the south-eastern side, the consequent valley floor being little above sea level. Outside the

Fig. 2. Active volcanic crater.

crater valley (Fig. 3) there is a radial topography with steep upper slopes and stable lower slopes extending to sea-cliffs or the shore. Because of the obvious volcanism, it is not generally realised that the lower slopes are sufficiently stable, and unaffected by volcanic activity, to support pohutukawa (*Metrosideros excelsa*) forest, smaller plants, continuing bird colonies, Maori rats, and small invertebrate animals.

The island has been fully described by Hamilton and Baumgart *et al* (*In* Hamilton & Baumgart, 1959), but only 1 species of marine Mollusca and 4 species of Insecta were recorded in a list of invertebrates. During a visit to the island, by the present author, it was obvious that the terrestrial invertebrates are much better represented than that list suggests. The purpose of this paper is to present a more substantial list in order to make it apparent that further collecting and study would be worthwhile. Some information on collecting methods is also given and the composition of the fauna in various localities and habitats is indicated in an ecological section.

Fig. 3. Western coast, showing white gannetry, pohutukawa forest, pohutukawa shrubland, and crater rim.

Collecting was carried out by the author only during a few hours at Crater Bay and for a day at Ohauora. Some specimens collected by an earlier expedition, mostly at Otaketake, are also recorded.

METHODS

In addition to observation and collection on the island, samples were taken and the fauna extracted in the Museum. It is as well to record here the system now adopted in the Entomology Department of this Museum. All samples, whether plant, soil, or any grade in between (leaf litter, rotting wood, etc.), are given a number in one catalogue series known as 'Plant/soil samples'. The method of extraction is noted in the catalogue but is not made a principal feature of the record. The present author does not now recognise the use of the term 'Berlese funnel', which puts an unnecessary stress on the extraction method and is, in fact, a misleading and often incorrect usage. The main point is that specimens have been extracted from a sample of a particular composition, e.g., moss, or of a particular kind, e.g., leaf litter. Frequently, the author takes two samples of the same material, simultaneously. Subsequently, the fauna is extracted from one of these per a funnel with top heat applied for 1-5 days, the fauna in the other being extracted per a cold funnel at unheated room temperatures over a period of 2 - 3 months. The top-heated

funnel method is thought to produce a sample of the most mobile fauna, while the unheated funnel usually produces more specimens of more species, including adults bred from larvae or pupae, and also adult parasites.

LIST OF SPECIES

Unless otherwise stated in the following list, all specimens were collected by the author on 5.XII.1966 at Crater Bay, or on 6.XII.1966 at Ohauora. Numbers in parenthesis after familial and higher taxon names are numbers of species; numbers in parenthesis amongst locality data are numbers of specimens. Plant names used are those recorded by Hamilton (*In* Hamilton & Baumgart, 1959).

Specimens have been sorted and determined by many specialists and the present author, as indicated for various groups. It has not been possible to specifically identify many of the specimens where groups are little known; numbers of specimens are not available for all species.

Phylum ANNELIDA (1) (Det. by K. E. Lee)

Class CHAETOPODA (1)

Order OLIGOCHAETA (1)

Family MEGASCOLECIDAE (1)

Subfamily MEGASCOLECINAE (1)

Diporochaeta obtusa Lee

Ohauora: pohutukawa leaf litter near landing, P/s sample 119 (1 clitellate, 7 aclitellate); rotten pohutukawa log, P/s sample 127 (2 aclitellate).

(Two lots broken in transit may have been the same species. Ohauora: pohutukawa leaf litter near landing, P/s sample 118; *Histiopteris* leaf litter, P/s sample 121. —K.A.J.W.)

Phylum ARTHROPODA (161)

Class DIPLOPODA (2) (Det. by P. M. Johns)

Order PLATYDESMIFORMIA (1)

Family SIPHONOPHORIDAE (1)

Siphonophora sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (several); pohutukawa leaf litter near landing, P/s sample 118 (1).

Order POLYDESMIDA (1)

Family DALODESMIDAE (= SPHAEROTRICHOPIDAE) (1)

sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (1), P/s sample 119 (several); *Histiopteris* leaf litter, P/s sample 120 (several), P/s sample 121 (several); rotten pohutukawa log, P/s sample 127 (several); wet pohutukawa leaf litter at top of forest, P/s sample 131 (2).

Class CHILOPODA (3) (Det. by author)
Order GEOPHILOMORPHA (1)
Family GEOPHILIDAE (1)

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (1); rotten pohutukawa log, P/s sample 127 (1).

Order LITHOBIOMORPHA (2)
Family HENICOPIDAE (2)
Subfamily HENICOPINAE (1)

sp.

Ohauora: landing (2); pohutukawa leaf litter near landing, P/s sample 119 (1); wet pohutukawa leaf litter at top of forest, P/s sample 130 (1).

Subfamily ANOPSOBIINAE (1)

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 120 (8), P/s sample 121 (13); low plants and grass above gannetry, P/s sample 124 (1); rotten pohutukawa log, P/s sample 127 (2); wet pohutukawa leaf litter at top of forest, P/s sample 131 (2).

Class INSECTA (111)
Subclass APTERYGOTA (12) (Det. by author)
Order COLLEMBOLA (11)
Suborder ARTHROPLEONA (10)
Section PODUROMORPHA (4)
Family NEANURIDAE (3)
Subfamily NEANURINAE (2)

Neanura novaezealandiae (Salmon, 1941)

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (4); *Histiopteris* leaf litter, P/s sample 121 (6); rotten pohutukawa log, P/s sample 127 (5).

Gnatholonche sensilla Salmon, 1948

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131 (1).

Subfamily PSEUDACHORUTINAE (1)

Pseudachorutes sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (2); rotten pohutukawa log, P/s sample 127 (4); wet pohutukawa leaf litter at top of forest, P/s sample 131 (4).

Family HYPOGASTRURIDAE (1)

Hypogastrura rossi (Salmon, 1941)

Crater Bay: *Disphyma australe* litter, P/s sample 117 (8).

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (3); wet pohutukawa leaf litter at top of forest, P/s sample 131 (4); *Coprosma* leaf litter, P/s sample 132 (2), P/s sample 133 (35); soil and debris at rock fall, P/s sample 134 (3).

Section ENTOMOBRYOMORPHA (6)

Family ISOTOMIDAE (4)

Subfamily PROISOTOMINAE (3)

Folsomina onychiurina Denis, 1931

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (1).

Proisotoma sp.

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131 (1).

Parafolsomia sp.

Ohauora: rotten pohutukawa log, P/s sample 127 (1).

Subfamily ISOTOMINAE (1)

? **Isotoma** sp.

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131 (1).

Family ENTOMOBRYIDAE (2)

Subfamily ENTOMOBRYINAE (2)

Entomobrya sp. A

Ohauora: (1); bark on rotting pohutukawa log, P/s sample 126 (9); rotten pohutukawa log, P/s sample 127 (12); wet pohutukawa leaf litter at top of forest, P/s sample 131 (3); soil and debris at rock fall, P/s sample 134 (3).

A species with blue markings.

Entomobrya sp. B

Ohauora: pohutukawa leaf litter near landing, P/s sample 119 (2); *Histiopteris* leaf litter, P/s sample 121 (3); wet pohutukawa leaf litter at top of forest, P/s sample 131 (4); *Coprosma* leaf litter, P/s sample 133 (2).

Suborder SYMPHYPLEONA (1)

Family SMINTHURIDAE (1)

Subfamily SMINTHURINAE (1)

Tribe KATIANNINI

Sminthurinus granulatus Salmon, 1941

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131 (4).

Order DIPLURA (1)

Family CAMPODEIDAE (1)

Metriocampa sp.

Ohauora: rotten pohutukawa log, P/s sample 127 (2).

Subclass PTERYGOTA (99)

Order DERMAPTERA (1) (Det. by author)

Family LABIDURIDAE (1)

Anisolabis littorea (White)

Crater Bay: under *Disphyma* (1); under wood (2).
Otaketake: (1), 19-22.XI.1964, C. J. Robertson.
Ohauora: gannetry, under stones (6).

Order PSOCOPTERA (5) (Det. by C. N. Smithers)

Family LIPOSCELIDAE (3)

Liposcelis sp. A

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (2).

Liposcelis sp. B

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (1).

Liposcelis sp. C

Ohauora: bark on rotting pohutukawa log, P/s sample 126 (2).

Family TROGIDAE ? (1)

sp.

Ohauora: bark on rotting pohutukawa log, P/s sample 126 (1)

Family CAECILIIDAE (1)

Subfamily PERIPSOCINAE (1)

Peripsocus sp. ? **morulops** (Till., 1923)

Ohauora: pohutukawa forest, swept (1)

Order HEMIPTERA (6)

Suborder HOMOPTERA (6)

Family CICADIDAE (1)

Melampsalta sericea

Recorded by Wodzicki & Robertson (*In* Hamilton & Baumgart, 1959). Many cicadas were heard and several seen by the author in the pohutukawa forest at Ohauora.

Family APHIDIDAE (2)

sp. A (Det. by author)

Ohauora: low plants and grass above gannetry, P/s sample 124 (1 nymph), P/s sample 125 (1 nymph).

sp. B (Det. by L. J. Dumbleton)

Crater Bay: under *Disphyma* (5♀♀); *Disphyma australe* and litter, P/s sample 117 (1 nymph).

Probably a root-infesting species.

Family PSYLLIDAE (1) (Det. by L. J. Dumbleton)

Trioza curta (Ferris & Klyver)

Ohauora: on undersides of leaves of juvenile pohutukawa in forest, immatures in pit galls (1♂, 13 nymphs).

Family PSEUDOCOCCIDAE (1) (Det. by L. J. Dumbleton)

sp.

Ohauora: in pit galls on undersides of leaves of juvenile pohutukawa in forest (1); pohutukawa leaf litter near landing, P/s sample 118 (1); pohutukawa leaf litter in shrubland, P/s sample 129 (1); wet pohutukawa leaf litter at top of forest, P/s sample 131 (2).

Family ERIOCOCCIDAE (1) (Det. by E. W. Valentine)

Eriococcus sp.

Ohauora: on underside of leaves from tops of trees at top of pohutukawa forest (1♂, several ♂ tests).

Order THYSANOPTERA (3) (Det. by Anne Ward)
Family PHLAEOTHRIPIDAE (1)

Amphibolothrips (Verrucothrips) sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (1).

An undescribed New Zealand species.

Family THRIPIDAE (2)

Aptinothrips rufus (Gmelin)

Ohauora: low plants and grass above gannetry, P/s sample 125 (4); pohutukawa leaf litter in shrubland, P/s sample 129 (1).

A cosmopolitan grass-species.

sp.

Crater Bay: *Disphyma australe* and litter, P/s sample 117 (1 immature).

Order TRICHOPTERA (1) (Det. by author)

Family PHILANISIDAE (1)

Philanisus plebeius Walker

Crater Bay: at light (1 ♀).
The common australasian marine caddis-fly.

Order LEPIDOPTERA (8) (Det. by J. S. Dugdale)

Family TINEIDAE (1)

Monopis ethelella Newman

Otaketake: (1 ♀), 17.XI.1964, C. J. Robertson.

Family OECOPHORIDAE (1)

Borkhausenia sp. ?

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (3 larvae).

Family TORTRICIDAE (1)

Subfamily TORTRICINAE (1)

Sperchia intractana Walker

Ohauora: *Coprosma* leaf litter, P/s sample 133 (1 ♂).
An Australian species known to occur in New Zealand.

Family PYRALIDAE (3)

Subfamily NYMPHULINAE (1)

Musotima sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 120 (1 larva).
Larvae feed on *Histiopteris* in New Zealand.

Subfamily SCOPARIINAE (1)

Scoparia sp.

Ohauora: pohutukawa forest, swept (1 ♂).

Subfamily PYRAUSTINAE (1)

Proternia philocapna Meyrick

Ohauora: low plants and grass above gannetry, P/s sample 125 (1).
A common New Zealand species.

Family GEOMETRIDAE (2)

Subfamily LARENTIINAE (2)

Xanthorhoe rosearia (Doubleday)

Crater Bay: under *Disphyma* (1 ♀, 1 pupa); *Disphyma australe* and litter, P/s sample 117 (7 larvae).

A New Zealand species, also occurring in similar halophyte communities on Chatham I.

Phrissogonus testulatus (Walker)

Ohauora: pohutukawa forest, swept (1 ♀).

A species common to Australia and New Zealand.

Order DIPTERA (36) (Det. by R. A. Harrison)

Family TIPULIDAE (2)

sp.

Otaketake: (1), 19-22.XI.1964, C. J. Robertson.

sp.

Crater Bay: flying at dusk (2); at light on boat (3), 6.XII.1966.

Otaketake: from inside tent (2), 19-22.XI.1964, C. J. Robertson; (2), 22.XI.1964, M. A. Crozier.

Family PSYCHODIDAE (1)

sp.

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131 (3).

Family CULICIDAE (1)

Opifex fuscus Hutt.

Ohauora Bay: F.W. pool (2, 6 pupae, 3 larvae), 21.XI.1964, M. A. Crozier.

Family MYCETOPHILIDAE (1)

sp.

Ohauora: pohutukawa forest, swept (1).

Family SCIARIDAE (3)

spp.

Otaketake: (1), 19-22.XI.1964, C. J. Robertson; inside tent (2), 22.XI.1964, M. A. Crozier.

Ohauora: pohutukawa forest, swept (2); swept above gannetry (1); landing (2); pohutukawa leaf litter near landing, P/s sample 118 (5), P/s sample 119 (2); *Histiopteris* leaf litter, P/s sample 124 (2); rotten pohutukawa log, P/s sample 127 (6); wet pohutukawa leaf litter at top of forest, P/s sample 131 (17).

Family CECIDOMYIIDAE (3)

spp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (2), P/s sample 119 (8); *Histiopteris* leaf litter, P/s sample 121 (7); guano and debris under stones in gannetry, P/s sample 122 (1); rotten pohutukawa log, P/s sample 127 (1); wet pohutukawa leaf litter at top of forest, P/s sample 131 (10); *Coprosma* leaf litter, P/s sample 133 (1).

Family DOLICHOPODIDAE (3) (Det. by D. J. Allan)

Tetrachaetus simplex Parent

Ohauora: pohutukawa forest, swept (5).

Abatetia sp.

Ohauora: shore landing, swept (10).

sp.

Crater Bay: (1).

Family PHORIDAE (2) (Det. by H. A. Oliver)

Antipodophora sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 119 (6); *Histiopteris* leaf litter, P/s sample 121 (3); rotten pohutukawa log, P/s sample 127 (3).

Diponevra sp. nr. **caudata**

Ohauora: guano and debris under stones in gannetry, P/s sample 123 (2); *Coprosma* leaf litter, P/s sample 133 (1).

Family LONCHOPTERIDAE (1)

Lonchoptera dubia Curr.

Crater Bay: (1).

Family SYRPHIDAE (2)

Eristalis tenax (L.)

Otaketake: (1), 19-22.XI.1964, C. J. Robertson.

Syrphus novaezealandiae Macq.

Crater Bay; swept (1).

Family HELOMYZIDAE (1)

Heloclusia aristata Harr.

Ohauora: landing (2); *Coprosma* leaf litter, P/s sample 133 (1).

Family AGROMYZIDAE (1)

Haplomyza (?) sp.

Crater Bay: (1).

Family PHYCODROMIDAE (1)

Chaetocoelopa littoralis (Hutt.)

Crater Bay: (1); at light (1).
Otaketake: inside tent (1), 22.XI.1964, M. A. Crozier.
Ohauora: high tidal pools, drowned (2), 19.XI.1964, M. A. Crozier; landing (2).

Family CHLOROPIDAE (1)

Lasiopleura wisei Harr.

Crater Bay: (3).
Otaketake: (3), 19-22.XI.1964, C. J. Robertson.
Ohauora: landing, swept (29); pohutukawa forest, swept (1).

Family EPHYDRIDAE (3)

Hecamede femoralis Mall.
Crater Bay: (2).

Hydrellia tritici Coq.
Ohauora: landing (2).

Neoscatella vittithorax (Mall.)
Crater Bay: (4).
Ohauora: shore landing, swept (2).

Family ASTEIIDAE (1)

Asteia levis Hutt.
Ohauora: landing (1).

Family DROSOPHILIDAE (1)

Scaptomyza flavella Harr.
Ohauora: landing (4).

Family BORBORIDAE (2)

Leptocera heteroneura (Hal.)
Ohauora: *Coprosma* leaf litter, P/s sample 133 (1).

Leptocera knightae Harr.
Crater Bay: (21).

Family CALLIPHORIDAE (2)

Calliphora laemica (White)
Crater Bay: (1).
Ohauora: (1).

Calliphora icela (Walk.)
Ohauora: landing, swept (1); swept above gannetry (1).

Family MUSCIDAE (3)

Calliphoroides antennatis (Hutt.)
Otaketake: (1), 19-22.XI.1964, C. J. Robertson.

spp.
Crater Bay: (1).
Otaketake: (3), 19-22.XI.1964, C. J. Robertson; inside tent (1), 22.XI.1964, M. A. Crozier.
Ohauora: high tidal pools, drowned (1), 19.XI.1964, M. A. Crozier; landing (1).

Family ? (1)

sp.

Ohauora: landing, swept (8).

Immatures

(Probably of various species and families recorded above —K.A.J.W.)

sp.

Ohauora: (1 larva).

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (7 larvae).

sp.

Ohauora: gannetry, under stone (1 pupa).

Order HYMENOPTERA (14) (Det. by E. W. Valentine)

Family FORMICIDAE (3) (Det. by R. W. Taylor)

Subfamily PONERINAE (1)

Amblyopone saundersi

Ohauora: *Histiopteris* leaf litter, P/s sample 120 (1 worker), P/s sample 121 (1 worker); wet pohutukawa leaf litter at top of forest, P/s sample 131 (1 queen).

Known from both main islands of New Zealand and Little Barrier I.

Subfamily MYRMICINAE (2)

Strumigenys perplexa

Ohauora: low plants and grass above gannetry, P/s sample 124 (1 worker).

Widespread in North Island and northern off-shore islands.

Chelaner antarcticus (White)

Crater Bay: under *Disphyma* (15 workers).

Otaketake: (2 workers), 19-22.XI.1964, C. J. Robertson.

Ohauora: guano and debris under stones in gannetry, P/s sample 122 (1 worker).

Present in the North I. and elsewhere.

Family COLLETIDAE (1)

Paracolletes sp. (? **boltoni)**

Crater Bay: swept (1); at light (1).

Ohauora: landing, at *Disphyma* flowers (3).

The native bee *Paracolletes boltoni,* was recorded on White I. by Wodzicki & Robertson (*In* Hamilton & Baumgart, 1959).

Family CRABRONIDAE (1)

Crabro sp.

Ohauora: landing (1).

Family EULOPHIDAE (1)

Chrysocharis sp.

Ohauora: landing (1).

Family DIAPRIDIDAE (3)

sp.

Ohauora: low plants and grass above gannetry, P/s sample 125 (1 ♀).

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 120 (1 ♀).

sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133 (1 ♂, 2 ♀♀).

Family MYMARIDAE (3)

Mymar pulchellum Curtis

Ohauora: low plants and grass above gannetry, P/s sample 124 (1).

Camptoptera sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (5 ♀♀); wet pohutukawa leaf litter at top of forest, P/s sample 131 (1 ♂); *Coprosma* leaf litter, P/s sample 133 (1 ♀).

Camptoptera sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133 (1 ♂).

Family CERAPHRONIDAE (1)

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (3 ♂♂, 6 ♀♀); rotten pohutukawa log, P/s sample 127 (1 ♂, 2 ♀♀); wet pohutukawa leaf litter at top of forest, P/s sample 131 (1 ♂).

Family EULOPHIDAE (1)

Hemiptarsenus sp.

Ohauora: low plants and grass above gannetry, P/s sample 124 (1♂).

Order COLEOPTERA (25) (Det. by J. C. Watt)

Family CARABIDAE (2)

Nemaglossa atriceps (Macleay)

Ohauora: *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; wet pohutukawa leaf litter at top of forest, P/s sample 131; landing.

Mecyclothorax rotundicollis (White)

Ohauora: pohutukawa leaf litter near landing, P/s sample 119 (1); wet pohutukawa leaf litter at top of forest, P/s sample 131 (1).

Immatures

spp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (larvae); wet pohutukawa leaf litter at top of forest, P/s sample 131 (larvae).

Family HISTERIDAE (1)

Saprinus sp. aff. **pseudocyaneus**

Mt. Gisborne: 244 m (800 ft) (1), 19-22.XI.1964, C. J. Robertson.

Family PTILIDAE (1)

sp.

Ohauora: bark on rotten pohutukawa log, P/s sample 126 (1).

Family ANISOTOMIDAE (1)

Subfamily CATOPINAE (1)

Mesocolon nesobium Jeannel

Ohauora: gannetry, under debris and stones (2); landing, swept (1); pohutukawa leaf litter near landing, P/s sample 119, *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; rotten pohutukawa log, P/s sample 127; *Coprosma* leaf litter, P/s sample 132, P/s sample 133.

Family SCYDMAENIDAE (1)

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (1).

Family STAPHYLINIDAE (1)

sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133 (2).

Immatures

sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (larvae), P/s sample 119 (larvae); rotten pohutukawa log, P/s sample 127 (larvae); wet pohutukawa leaf litter at top of forest, P/s sample 130 (larvae), P/s sample 131 (larvae); *Coprosma* leaf litter, P/s sample 133 (larvae).

Family PSELAPHIDAE (1)

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (2).

Family CLAMBIDAE (1)

Clambus sp.

Ohauora: rotten pohutukawa log, P/s sample 127 (1).

Family ELATERIDAE (1)
Immatures

sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 119 (1 larva); *Histiopteris* leaf litter, P/s sample 120 (1 larva).

Family LYCIDAE (1)

Metriorhynchus erraticus

Recorded by Wodzicki & Robertson (*In* Hamilton & Baumgart, 1959).

Family NITIDULIDAE (1)

Epuraea sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133 (2); soil and debris at rock fall, P/s sample 134 (1).

Immatures

sp.

Ohauora: *Coprosma* leaf litter. P/s sample 132 (larvae); P/s sample 133 (larvae).

Family CORYLOPHIDAE (1)

sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133 (1).

Immatures

sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133 (1 larva).

Family COCCINELLIDAE (1)

Coccinella undecimpunctata L.

Ohauora: swept above gannetry (1).

This species was recorded on White I. by Wodzicki & Robertson (*In* Hamilton & Baumgart, 1959); it was abundant on the crater rim on 13.I.1947.

Family MEROPHYSIIDAE (2)

Holoparamecus spp.

Crater Bay: *Disphyma australe* and litter, P/s sample 117.

Ohauora: pohutukawa leaf litter near landing, P/s sample 119; bark on rotting pohutukawa log, P/s sample 126; rotten pohutukawa log, P/s sample 127; wet pohutukawa leaf litter at top of forest, P/s sample 131.

Immatures

spp.

Ohauora: rotten pohutukawa log, P/s sample 127 (larvae); wet pohutukawa leaf litter at top of forest, P/s sample 131 (larvae).

Family LATHRIDIIDAE (3)

Lathridius spp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (1); wet pohutukawa leaf litter at top of forest, P/s sample 131 (1); *Coprosma* leaf litter, P/s sample 133 (1).

Melanophthalma sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (1); low plants and grass above gannetry, P/s sample 124 (1); wet pohutukawa leaf litter at top of forest, P/s sample 131 (1); *Coprosma* leaf litter, P/s sample 133 (1).

Immatures

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (3 larvae).

Family COLYDIIDAE (3)

Coxelus spp.

Ohauora: under bark rotting pohutukawa logs; pohutukawa leaf litter near landing, P/s sample 119; *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; low plants and grass above gannetry, P/s sample 124; wet pohutukawa leaf litter at top of forest, P/s sample 131; *Coprosma* leaf litter, P/s sample 133.

sp.

Ohauora: bark on rotting pohutukawa log, P/s sample 126 (2).

Immatures

spp.

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (larvae); low plants and grass above gannetry, P/s sample 125 (larvae).

Family TENEBRIONIDAE (1)

Tenebrio obscurus (Fab.)

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131 (1).

Family CURCULIONIDAE (2)

Subfamily COSSONINAE (1)

Euophryum rufum (Broun) (Det. by G. Kuschel)

Ohauora: under bark rotting pohutukawa logs (1); rotten pohutukawa log, P/s sample 127 (1).

(Two lots lost in transit, one was probably *Euophryum*.

Ohauora: under bark rotting pohutukawa logs (2); gannetry, under debris and stones (1). —K.A.J.W.).

Immatures (Det. by B. M. May)

Subfamily ERIRRHINAE (1)

sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133 (1 larva).

Class CRUSTACEA (1) (Det. by author)

Subclass MALACOSTRACA (1)

Order Amphipoda (1)

sp.

Otaketake: (1), 19-22.XI.1964, C. J. Robertson.

Ohauora: pohutukawa leaf litter near landing, P/s sample 119 (1); low plants and grass above gannetry, P/s sample 124 (2); rotten pohutukawa log, P/s sample 127 (1); wet pohutukawa leaf litter at top of forest, P/s sample 130 (1), P/s sample 131 (2).

Class ARACHNIDA (44)

Order PSEUDOSCORPIONIDEA (3) (Det. by M. Beier)

Family CHTHONIIDAE (1)

Austrochthonius inversus Beier

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (2 ♂♂, 1 ♀, 1 nymph), P/s sample 119 (6♂♂, 5♀♀); *Histiopteris* leaf litter, P/s sample 120 (13 ♂♂, 2 ♀♀), P/s sample 121 (10♂♂, 11♀♀, 10 nymphs); low plants and grass above gannetry, P/s sample 124 (1 ♂, 1 nymph); rotten pohutukawa log, P/s sample 127 (1 nymph); wet pohutukawa leaf litter at top of forest, P/s sample 131 (5 ♂♂, 11 ♀♀, 8 nymphs).

Family OLPIIDAE (1)

Euryolpium (Antiolpium) zealandiense (Hoff.)

Ohauora: pohutukawa shrubland, under stones (2); under bark rotting pohutukawa logs (5); pohutukawa leaf litter near landing, P/s sample 119 (1 ♂).

Family IDEOBISIIDAE (1)

Ideobisium peregrinum Chamb.

Ohauora: *Histiopteris* leaf litter, P/s sample 120 (2 ♂♂, 2 ♀♀, 2 nymphs).

Order ARANEAE (10) (Det. by R. R. Forster)

Family EPEIRIDAE (2)

Aranea sp.

Ohauora: landing (1); pohutukawa forest (1).

Aranea pustulosa

Ohauora: (1), 21.XI.1964, M. A. Crozier; pohutukawa forest (2).

Family CLUBIONIDAE (1)

Clubiona sp.

Otaketake: inside tent (1), 22.XI.1964, M. A. Crozier.

Family LINYPHIIDAE (1)

sp.

Otaketake: (1), 17.XI.1964, C. J. Robertson.

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (several), P/s sample 119 (several); *Histiopteris* leaf litter, P/s sample 120 (several), P/s sample 121 (several).

Family AGALENIDAE (1)

sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (several); *Histiopteris* leaf litter, P/s sample 120 (several), P/s sample 121 (several); wet pohutukawa leaf litter at top of forest, P/s sample 131 (3).

Family DICTYNIDAE (2)

sp. A

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (several); *Histiopteris* leaf litter, P/s sample 120 (several), P/s sample 121 (several); pohutukawa leaf litter in shrubland, P/s sample 128 (1).

sp. B

Otaketake: (1), 17.XI.1964, C. J. Robertson.

Family SALTICIDAE (1)

sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133 (1).

Family LYCOSIDAE (1)

sp.

Crater Bay: under *Disphyma* (1).
Otaketake: (3), 19-22.XI.1964, C. J. Robertson.
Ohauora: low plants and grass above gannetry, P/s sample 124 (2).
Crater rim: S.W. side, 244 m (800 ft) (1), 6.XII.1966, L. Carter.

Family THERIDIIDAE (1)

Pholcomma sp.

Ohauora: bark on rotting pohutukawa log, P/s sample 126 (1).

Subclass ACARI (31) (Det. by M. Luxton)

Order CRYPTOSTIGMATA (15)

Family CAMISIIDAE (1)

Platynothrus tenuiclava Hammer, 1966

Ohauora: *Coprosma* leaf litter, P/s sample 132, P/s sample 133.

Family TRHYPOCHTHONIIDAE (1)

Allonothrus n. sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; low plants and grass above gannetry, P/s sample 124; rotten pohutukawa log, P/s sample 127; *Coprosma* leaf litter, P/s sample 133.

Family CARABODIDAE (1)

Austrocarabodes nodosus Hammer, 1966

Ohauora: *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; low plants and grass above gannetry, P/s sample 124; rotten pohutukawa log, P/s sample 127.

Family PHTHIRACARIDAE (1)

Holophorella n. sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 118; *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; rotten pohutukawa log, P/s sample 127; wet pohutukawa leaf litter at top of forest, P/s sample 131.

Family ORIBATULIDAE (3)

Ingella n. sp.

Ohauora: bark on rotting pohutukawa log, P/s sample 126; *Coprosma* leaf litter, P/s sample 133.

Totobates ovalis Hammer, 1967

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131.

Scheloribates conjuges Hammer, 1967

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131.

Family MYCOBATIDAE (1)

Anellozetes longicaulis Hammer, 1967

Ohauora: rotten pohutukawa log, P/s sample 127.

Family METRIOPPIIDAE (1)

Pseudoceratoppia microsetosa Hammer, 1967

Ohauora: rotten pohutukawa log, P/s sample 127.

Family SUCTOBELBIDAE (1)

Zeasuctobelba trinodosa Hammer, 1966

Ohauora: *Histiopteris* leaf litter, P/s sample 121.

Family OPPIIDAE (5)

Amerioppia n. sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 119; *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; rotten pohutukawa log, P/s sample 127; *Coprosma* leaf litter, P/s sample 133.

Oppia n. sp. 1

Ohauora: pohutukawa leaf litter near landing, P/s sample 118, P/s sample 119; *Histiopteris* leaf litter, P/s sample 121; wet pohutukawa leaf litter at top of forest, P/s sample 131.

Oppia n. sp. 2

Ohauora: *Histiopteris* leaf litter, P/s sample 121.

Globoppia n. sp. 1

Ohauora: pohutukawa leaf litter near landing, P/s sample 118, P/s sample 119; *Histiopteris* leaf litter, P/s sample 121; low plants and grass above gannetry, P/s sample 124; rotten pohutukawa log, P/s sample 127; wet pohutukawa leaf litter at top of forest, P/s sample 130, P/s sample 131; *Coprosma* leaf litter, P/s sample 132.

Globoppia n. sp. 2

Ohauora: pohutukawa leaf litter near landing, P/s sample 118; *Histiopteris* leaf litter, P/s sample 120; low plants and grass above gannetry, P/s sample 124; rotten pohutukawa log, P/s sample 127; wet pohutukawa leaf litter at top of forest, P/s sample 131; *Coprosma* leaf litter, P/s sample 133.

Order METASTIGMATA (1)

Family IXODIDAE (1) (Det. by L. J. Dumbleton)

Ixodes eudyptidis Mask.

Ohauora: gannetry, under stone (4♂♂, 2♀♀, 3 nymphs); rotten pohutukawa log, P/s sample 127.

Order MESOSTIGMATA (12)

Family LIROASPIDAE (1)

Epicroseius n. sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 119; *Histiopteris* leaf litter, P/s sample 121; low plants and grass above gannetry, P/s sample 124; rotten pohutukawa log, P/s sample 127; wet pohutukawa leaf litter at top of forest, P/s sample 131; *Coprosma* leaf litter, P/s sample 133.

Family UROPODIDAE (2)

sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 119; *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; guano and debris under stones in gannetry, P/s sample 122; low plants and grass above gannetry, P/s sample 124, P/s sample 125; bark on rotting pohutukawa log, P/s sample 126; rotten pohutukawa log, P/s sample 127; pohutukawa leaf litter in shrubland, P/s sample 129; wet pohutukawa leaf litter at top of forest, P/s sample 131.

sp.

Ohauora: *Histiopteris* leaf litter, P/s sample 120.

Family RHODACARIDAE (2)

Digamasellus n. sp.

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131.

Cyrtolaelaps n. sp.

Ohauora: pohutukawa leaf litter near landing, P/s sample 119; *Histiopteris* leaf litter, P/s sample 120, P/s sample 121; low plants and grass above gannetry, P/s sample 124; rotten pohutukawa log, P/s sample 127; wet pohutukawa leaf litter at top of forest, P/s sample 131.

Family PHYTOSEIIDAE (1)

Amblyseius sp.

Ohauora: low plants and grass above gannetry, P/s sample 125.

Family MACROCHELIDAE (1)

Macrocheles aff. **matrius** (Hull, 1925)

Ohauora: guano and debris under stones in gannetry, P/s sample 122.

Family BLATTISOCIIDAE (1)

Lasioseius n. sp.

Ohauora: bark on rotting pohutukawa log, P/s sample 126.

Family AMEROSEIIDAE (1)

Ameroseius aff. **ornatus** Womersley, 1956

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131; *Coprosma* leaf litter, P/s sample 133.

Family DERMANYSSIDAE (3)

Cosmolaelaps n. sp. 1

Ohauora: *Coprosma* leaf litter, P/s sample 132, P/s sample 133.

Cosmolaelaps n. sp. 2

Ohauora: bark on rotting pohutukawa log, P/s sample 126; rotten pohutukawa log, P/s sample 127.

? **Gaeolaelaps** sp.

Ohauora: *Coprosma* leaf litter, P/s sample 133.

Order PROSTIGMATA (1)
Family PYEMOTIDAE (1)

Pyemotes sp.

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131.

Order ASTIGMATA (2)
Family TYROGLYPHIDAE (1)

Tyrophagus longior (Gervais, 1844)

Ohauora: pohutukawa leaf litter near landing, P/s sample 119; *Coprosma* leaf litter, P/s sample 133.

Superfamily CANESTRINIOIDEA (1)

sp.

Ohauora: guano and debris under stones in gannetry, P/s sample 122, P/s sample 123.

ECOLOGY

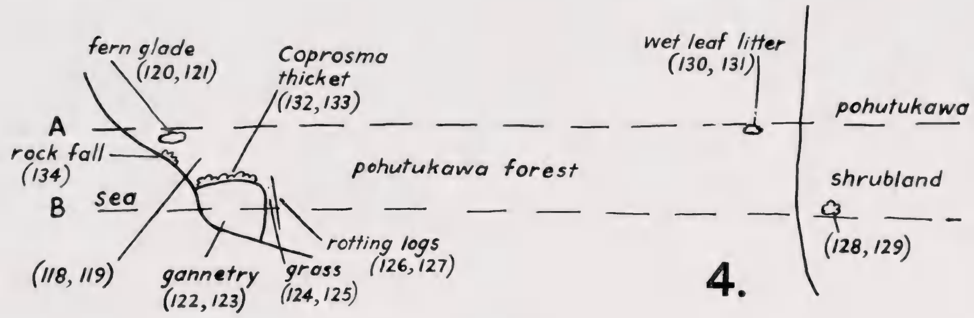
Only a brief examination of communities and associations was possible in the time available on White Island. However, because of the nature of the island, the information gained is collated here. The Otaketake collections were made by a previous expedition.

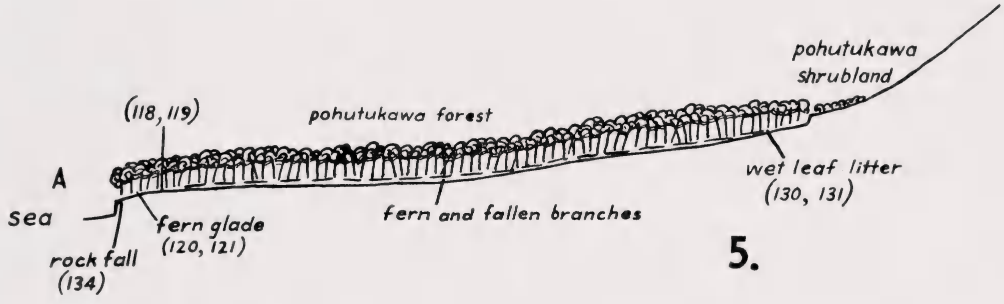
In Crater Bay, debris on the shore, clumps of iceplant (*Disphyma australe* (Sol.) J. M. Black), and the crater floor, were examined. At Ohauora, several different communities and associations were examined. Schematic diagrams of the area are presented in Figs. 4-6, and approximate sites where samples were taken are indicated. Collecting and sampling were carried out from the rocky shore landing place via a gannetry (of the australasian gannet, *Sula bassana serrator*) and pohutukawa forest to the pohutukawa shrubland and back by a different route. The Ohauora data, in the following lists, are arranged more or less from the shore, inland.

Near the landing, samples were taken from debris in a small rock fall, from leaf litter under pohutukawa trees (*Metrosideros excelsa* Sol.), and from leaf litter under fern (*Histiopteris incisa* J. Sm.) in a small glade. Beside the gannetry, which was on a small headland, was a thicket of *Coprosma repens* Rich. (Fig. 7); this and the gannetry were sampled. Samples were also taken from a narrow strip of grass and low plants between the gannetry and the pohutukawa forest, and from rotting pohutukawa logs at the edge of the forest (Fig. 8). The trees in the forest are up to 14 m (45 ft) in height, with fern and rotting branches beneath (Fig. 9), and the forest extends over most of the lower slopes as far inland as a sharp rise, which in one place is a 9 m (30 ft) cliff. Above this is the pohutukawa shrubland on the lower part of the upper slopes (Fig. 10). Leaf litter samples were taken in the shrubland and in a small wet patch of deep litter in a channel in the upper part of the forest.

Crater Bay.

sp.	(Diptera: Dolichopodidae)	(1)
Lonchoptera dubia	(Diptera: Lonchopteridae)	(1)
Syrphus novaezealandiae	(Diptera: Syrphidae)	(1)
Haplomyza (?) sp.	(Diptera: Agromyzidae)	(1)
Chaetocoelopa littoralis	(Diptera: Phycodromidae)	(1)
Lasiopleura wisei	(Diptera: Chloropidae)	(3)
Hecamede femoralis	(Diptera: Ephydridae)	(2)
Neoscatella vittithorax	(Diptera: Ephydridae)	(4)
Leptocera knightae	(Diptera: Borboridae)	(21)
Calliphora laemica	(Diptera: Calliphoridae)	(1)
spp.	(Diptera: Muscidae)	(1)
Paracolletes sp. (? *boltoni*)	(Hymenoptera: Colletidae)	(1)





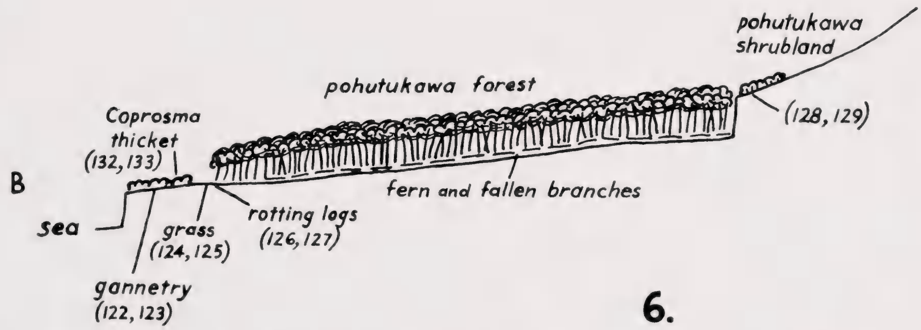


Fig. 4 - 6. Schematic diagrams of Ohauora. (Numbers in brackets are P/s sample numbers.) 4. Map view, positions of profiles A, B, shown. 5. Profile A. 6. Profile B.

Fig. 7. *Coprosma repens* thicket beside gannetry.

Fig. 8. Grass strip above gannetry, rotting logs and branches at edge of pohutukawa forest.

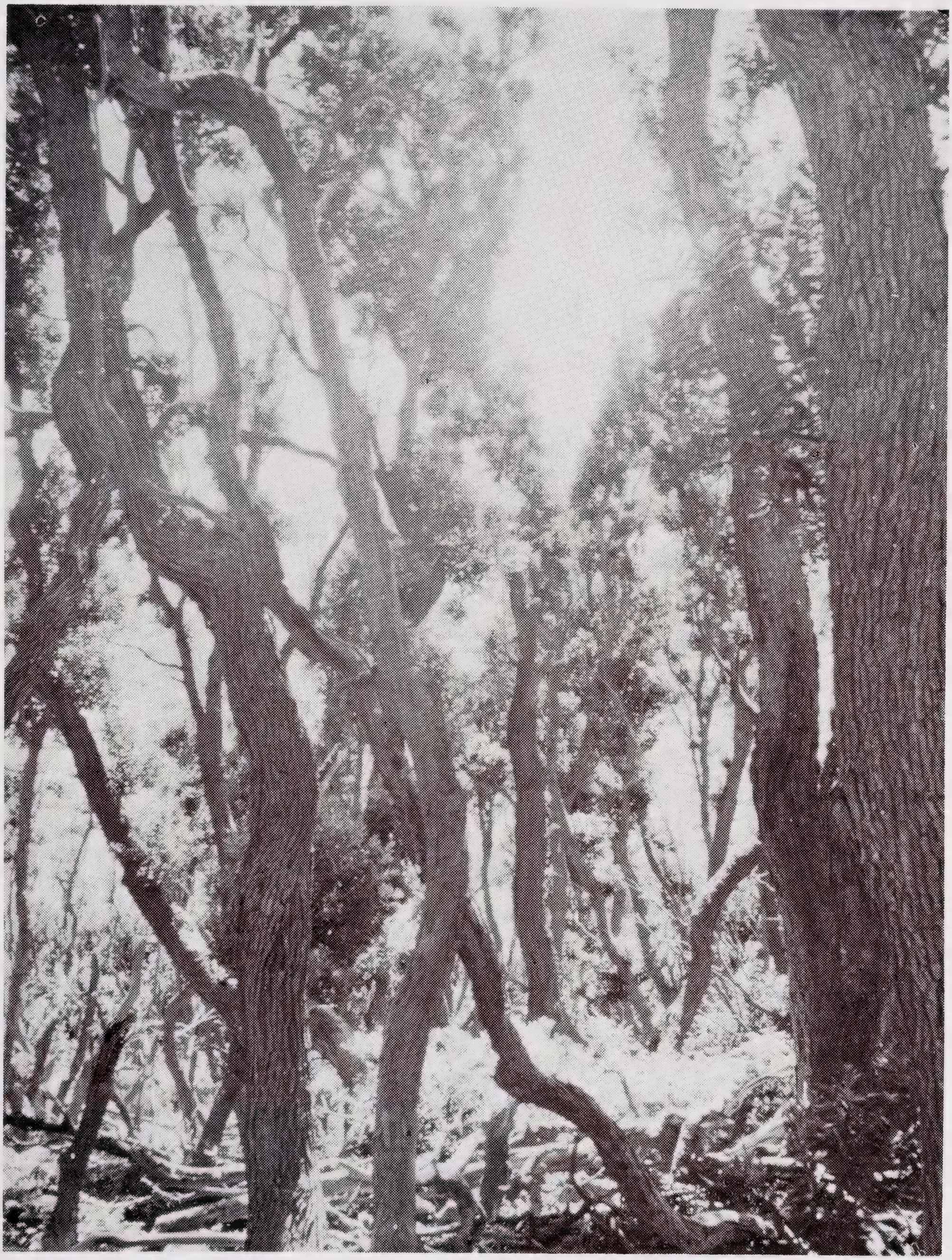


Fig. 9. Pohutukawa forest with rotting branches and fern beneath.

Fig. 10. Pohutukawa shrubland.

Crater Bay: under *Disphyma.*

Anisolabis littorea	(Dermaptera: Labiduridae)	(1)
Xanthorhoe rosearia	(Lepidoptera: Geometridae)	(1♀, 1 pupa)
Chelaner antarcticus	(Hymenoptera: Formicidae)	(15 workers)
sp.	(Araneae: Lycosidae)	(1)

Crater Bay: under wood.

Anisolabis littorea	(Dermaptera: Labiduridae)	(2)

Crater Bay: *Disphyma australe* and litter, P/s sample 117 (funnel extraction with top heat).

Hypogastrura rossi	(Collembola: Hypogastruridae)	(8)
sp. B	(Hemiptera: Aphididae)	(1 nymph)
sp.	(Thysanoptera: Thripidae)	(1)
Xanthorhoe rosearia	(Lepidoptera: Geometridae)	(7 larvae)
Holoparamecus spp.	(Coleoptera: Merophysiidae)	

Crater Bay: flying at night.

Philanisus plebeius	(Trichoptera: Philanisidae)	(1♀)
sp.	(Diptera: Tipulidae)	(5)
Chaetocoelopa littoralis	(Diptera: Phycodromidae)	(1)
Paracolletes sp. (? *boltoni*)	(Hymenoptera: Colletidae)	(1)

Otaketake.

Anisolabis littorea	(Dermaptera: Labiduridae)	(1)
Monopis ethelella	(Lepidoptera: Tineidae)	(1♀)
sp.	(Diptera: Tipulidae)	(1)
sp.	(Diptera: Tipulidae)	(4)
sp.	(Diptera: Sciaridae)	(3)
Eristalis tenax	(Diptera: Syrphidae)	(1)
Chaetocoelopa littoralis	(Diptera: Phycodromidae)	(1)
Lasiopleura wisei	(Diptera: Chloropidae)	(3)
Calliphoroides antennatus	(Diptera: Muscidae)	(1)
spp.	(Diptera: Muscidae)	(4)
Chelaner antarcticus	(Hymenoptera: Formicidae)	(2 workers)
sp.	(Amphipoda: ?)	(1)
Clubiona sp.	(Araneae: Clubionidae)	(1)
sp.	(Araneae: Linyphiidae)	(1)
sp. B	(Araneae: Dictynidae)	(1)
sp.	(Araneae: Lycosidae)	(3)

Ohauora.

Entomobrya sp. A	(Collembola: Entomobryidae)	(1)
Calliphora laemica	(Diptera: Calliphoridae)	(1)
sp.	(Diptera: ?)	(1 larva)
Aranea pustulosa	(Araneae: Epeiridae)	(1)

Ohauora: shore.

Opifex fuscus	(Diptera: Culicidae)	(2, 6 pupae, 3 larvae)
sp.	(Diptera: Sciaridae)	(2)
Abatetia sp.	(Diptera: Dolichopodidae)	(10)
Heloclusia aristata	(Diptera: Helomyzidae)	(2)
Chaetocoelopa littoralis	(Diptera: Phycodromidae)	(4)
Lasiopleura wisei	(Diptera: Chloropidae)	(29)
Hydrellia tritici	(Diptera: Ephydridae)	(2)
Neoscatella vittithorax	(Diptera: Ephydridae)	(2)
Asteia levis	(Diptera: Asteiidae)	(1)
Scaptomyza flavella	(Diptera: Drosophilidae)	(4)

Calliphora icela	(Diptera: Calliphoridae)	(1)
spp.	(Diptera: Muscidae)	(2)
sp.	(Diptera: ?)	(8)
Crabro sp.	(Hymenoptera: Crabronidae)	(1)
Chrysocharis sp.	(Hymenoptera: Eulophidae)	(1)
Mesocolon nesobium	(Coleoptera: Anisotomidae)	(1)
Aranea sp.	(Araneae: Epeiridae)	(1)

Ohauora: landing, at *Disphyma* flowers.

Paracolletes sp. (? *boltoni*)	(Hymenoptera: Colletidae)	(3)

Ohauora: soil and debris at rock fall, P/s sample 134 (cold funnel extraction).

Hypogastrura rossi	(Collembola: Hypogastruridae)	(3)
Entomobrya sp. A	(Collembola: Entomobryidae)	(3)
Epuraea sp.	(Coleoptera: Nitidulidae)	(1)

Ohauora: pohutukawa leaf litter near landing, P/s sample 118 (funnel extraction with top heat).

sp.	(Oligochaeta: ?)	
Siphonophora sp.	(Platydesmiformia: Siphonophoridae)	
sp.	(Polydesmida: Dalodesmidae)	
Neanura novaezealandiae	(Collembola: Neanuridae)	(4)
Hypogastrura rossi	(Collembola: Hypogastruridae)	(3)
sp.	(Hemiptera: Pseudococcidae)	(1)
sp.	(Diptera: Sciaridae)	(5)
sp.	(Diptera: Cecidomyiidae)	(2)
spp.	(Coleoptera: Carabidae)	(larvae)
sp.	(Coleoptera: Staphylinidae)	(larvae)
Austrochthonius inversus	(Pseudoscorpiones: Chthoniidae)	(2 ♂ ♂, 1 ♀, 1 nymph)
sp.	(Araneae: Linyphiidae)	(several)
sp.	(Araneae: Agalenidae)	(several)
sp. A	(Araneae: Dictynidae)	(several)
Holophorella n. sp.	(Cryptostigmata: Phthiracaridae)	
Oppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 2	(Cryptostigmata: Oppiidae)	

Ohauora: pohutukawa leaf litter near landing, P/s sample 119 (cold funnel extraction).

Diporochaeta obtusa	(Oligochaeta: Megascolecidae)	(1 clitellate, 1 aclitellate)
sp.	(Polydesmida: Dalodesmidae)	
sp.	(Lithobiomorpha: Henicopidae)	(1)
Entomobrya sp. B	(Collembola: Entomobryidae)	(2)
sp.	(Diptera: Sciaridae)	(2)
sp.	(Diptera: Cecidomyiidae)	(8)
Antipodophora sp.	(Diptera: Phoridae)	(6)
Mecyclothorax rotundicollis	(Coleoptera: Carabidae)	(1)
Mesocolon nesobium	(Coleoptera: Anisotomidae)	
sp.	(Coleoptera: Staphylinidae)	(larvae)
sp.	(Coleoptera: Elateridae)	(1 larva)
Holoparamecus spp.	(Coleoptera: Merophysiidae)	
Coxelus spp.	(Coleoptera: Colydiidae)	
sp.	(Amphipoda: ?)	(1)
Austrochthonius inversus	(Pseudoscorpiones: Chthoniidae)	(6 ♂ ♂, 5 ♀ ♀)
Euryolpium (Antiolpium) zealandense	(Pseudoscorpiones: Olpiidae)	(1 ♂)
sp.	(Araneae: Linyphiidae)	(several)
Amerioppia n. sp.	(Cryptostigmata: Oppiidae)	
Oppia sp. 1	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Epicroseius n. sp.	(Mesostigmata: Liroaspidae)	
sp.	(Mesostigmata: Europodidae)	
Cyrtolaelaps n. sp.	(Mesostigmata: Rhodacaridae)	
Tyrophagus longior	(Astigmata: Tyroglyphidae)	

Ohauora: *Histiopteris* leaf litter, P/s sample 120 (funnel extraction with top heat).

sp.	(Polydesmida: Dalodesmidae)	
sp.	(Lithobiomorpha: Henicopidae)	(8)
Musotima sp.	(Lepidoptera: Pyralidae)	(1 larva)
Amblyopone saundersi	(Hymenoptera: Formicidae)	(1 worker)
sp.	(Hymenoptera: Diaprididae)	(1♀)
Nemaglossa atriceps	(Coleoptera: Carabidae)	
Mesocolon nesobium	(Coleoptera: Anisotomidae)	
sp.	(Coleoptera: Elateridae)	(1 larva)
Coxelus spp.	(Coleoptera: Colydiidae)	
Austrochthonius inversus	(Pseudoscorpiones: Chthoniidae)	(13♂♂, 2♀♀)
Ideobisium peregrinum	(Pseudoscorpiones: Ideobisiidae)	(2♂♂, 2♀♀, 2 nymphs)
sp.	(Araneae: Linyphiidae)	(several)
sp.	(Araneae: Agalenidae)	(several)
sp. A	(Araneae: Dictynidae)	(several)
Allonothrus n. sp.	(Cryptostigmata: Trhypochthoniidae)	
Austrocarabodes nodosus	(Cryptostigmata: Carabodidae)	
Holophorella n. sp.	(Cryptostigmata: Phthiracaridae)	
Amerioppia n. sp.	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 2	(Cryptostigmata: Oppiidae)	
sp.	(Mesostigmata: Uropodidae)	
sp.	(Mesostigmata: Uropodidae)	
Cyrtolaelaps n. sp.	(Mesostigmata: Rhodacaridae)	

Ohauora: *Histiopteris* leaf litter, P/s sample 121 (cold funnel extraction).

sp.	(Oligochaeta: ?)	
Siphonophora sp.	(Platydesmiformia: Siphonophoridae)	
sp.	(Polydesmida: Dalodesmidae)	
sp.	(Geophilomorpha: Geophilidae)	
sp.	(Lithobiomorpha: Henicopidae)	(13)
Pseudachorutes sp.	(Collembola: Neanuridae)	(2)
Neanura novaezealandiae	(Collembola: Neanuridae)	(6)
Folsomia onychiurina	(Collembola: Isotomidae)	(1)
Entomobrya sp. B	(Collembola: Entomobryidae)	(3)
Liposcelis sp. A	(Psocoptera: Liposcelidae)	(2)
Liposcelis sp. B	(Psocoptera: Liposcelidae)	(1)
Amphibolothrips (Verrucothrips) sp.	(Thysanoptera: Phlaeothripidae)	(1)
Borkhausenia sp. ?	(Lepidoptera: Oecophoridae)	(3 larvae)
sp.	(Diptera: Sciaridae)	(7)
sp.	(Diptera: Cecidomyiidae)	(7)
Antipodophora sp.	(Diptera: Phoridae)	(3)
sp.	(Diptera: ?)	(7 larvae)
Amblyopone saundersi	(Hymenoptera: Formicidae)	(1 worker)
Camptoptera sp.	(Hymenoptera: Mymaridae)	(5♀♀)
sp.	(Hymenoptera: Ceraphronidae)	(3♂♂, 6♀♀)
Nemaglossa atriceps	(Coleoptera: Carabidae)	
Mesocolon nesobium	(Coleoptera: Anisotomidae)	
sp.	(Coleoptera: Scydmaenidae)	(1)
sp.	(Coleoptera: Pselaphidae)	(2)
Lathridius spp.	(Coleoptera: Lathridiidae)	(1)
Melanophthalma sp.	(Coleoptera: Lathridiidae)	(1)
sp.	(Coleoptera: Lathridiidae)	(3 larvae)
Coxelus spp.	(Coleoptera: Colydiidae)	
spp.	(Coleoptera: Colydiidae)	(larvae)
Austrochthonius inversus	(Pseudoscorpiones: Chthoniidae)	(10♂♂, 11♀♀, 10 nymphs)
sp.	(Araneae: Linyphiidae)	(several)
sp.	(Araneae: Agalenidae)	(several)
sp. A	(Araneae: Dictynidae)	(several)
Allonothrus n. sp.	(Cryptostigmata: Trhypochthoniidae)	
Austrocarabodes nodosus	(Cryptostigmata: Carabodidae)	
Holophorella n. sp.	(Cryptostigmata: Phthiracaridae)	
Zeasuctobelba trinodosa	(Cryptostigmata: Suctobelbidae)	

Amerioppia n. sp.	(Cryptostigmata: Oppiidae)	
Oppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Oppia n. sp. 2	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Epicroseius n. sp.	(Mesostigmata: Liroaspidae)	
sp.	(Mesostigmata: Europodidae)	
Cyrtolaelaps n. sp.	(Mesostigmata: Rhodacaridae)	

Ohauora: *Coprosma* leaf litter, P/s sample 132 (funnel extraction with top heat).

Hypogastrura rossi	(Collembola: Hypogastruridae)	(2)
Mesocolon nesobium	(Coleoptera: Anisotomidae)	
sp.	(Coleoptera: Nitidulidae)	(larvae)
Platynothrus tenuiclava	(Cryptostigmata: Camisiidae)	
Globoppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Cosmolaelaps n. sp. 1	(Mesostigmata: Dermanyssidae)	

Ohauora: *Coprosma* leaf litter, P/s sample 133 (cold funnel extraction).

Hypogastrura rossi	(Collembola: Hypogastruridae)	(35)
Entomobrya sp. B	(Collembola: Entomobryidae)	(2)
Sperchia intractana	(Lepidoptera: Tortricidae)	(1 ♂)
sp.	(Diptera: Cecidomyiidae)	(1)
Diponevra sp. nr. *caudata*	(Diptera: Phoridae)	(1)
Heloclusia aristata	(Diptera: Helomyzidae)	(1)
Leptocera heteroneura	(Diptera: Borboridae)	(1)
sp.	(Hymenoptera: Diaprididae)	(1 ♂, 2 ♀ ♀)
Camptoptera sp.	(Hymenoptera: Mymaridae)	(1 ♀)
Camptoptera sp.	(Hymenoptera: Mymaridae)	(1 ♂)
Mesocolon nesobium	(Coleoptera: Anisotomidae)	
sp.	(Coleoptera: Staphylinidae)	(2)
sp.	(Coleoptera: Staphylinidae)	(larvae)
Epuraea sp.	(Coleoptera: Nitidulidae)	(2)
sp.	(Coleoptera: Nitidulidae)	(larvae)
sp.	(Coleoptera: Corylophidae)	(1)
sp.	(Coleoptera: Corylophidae)	(1 larva)
Lathridius spp.	(Coleoptera: Lathridiidae)	(1)
Melanophthalma sp.	(Coleoptera: Lathridiidae)	(1)
Coxelus spp.	(Coleoptera: Colydiidae)	
sp.	(Coleoptera: Curculionidae)	(1 larva)
sp.	(Araneae: Salticidae)	(1)
Platynothrus tenuiclava	(Cryptostigmata: Camisiidae)	
Allonothrus n. sp.	(Cryptostigmata: Trhypochthoniidae)	
Ingella n. sp.	(Cryptostigmata: Oribatulidae)	
Amerioppia n. sp.	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 2	(Cryptostigmata: Oppiidae)	
Epicroseius n. sp.	(Mesostigmata: Liroaspidae)	
Ameroseius aff. *ornatus*	(Mesostigmata: Ameroseiidae)	
Cosmolaelaps n. sp. 1	(Mesostigmata: Dermanyssidae)	
? *Gaeolaelaps* sp.	(Mesostigmata: Dermanyssidae)	
Tyrophagus longior	(Astigmata: Tyroglyphidae)	

Ohauora: gannetry, swept.

sp.	(Diptera: Sciaridae)	(1)
Calliphora icela	(Diptera: Calliphoridae)	(1)
Coccinella undecimpunctata	(Coleoptera: Coccinellidae)	(1)

Ohauora: gannetry, under stones.

Anisolabis littorea	(Dermaptera: Labiduridae)	(6)
sp.	(Diptera: ?)	(1 pupa)
Mesocolon nesobium	(Coleoptera: Anisotomidae)	(2)
sp.	(Coleoptera: Curculionidae)	(1)
Ixodes eudyptidis	(Megastigmata: Ixodidae)	(4 ♂ ♂, 2 ♀ ♀, 3 nymphs)

Ohauora: guano and debris under stones in gannetry, P/s sample 122 (funnel extraction with top heat).

sp.	(Diptera: Cecidomyiidae)	(1)
Chelaner antarcticus	(Hymenoptera: Formicidae)	(1 worker)
sp.	(Mesostigmata: Uropodidae)	
Macrocheles aff. *matrius*	(Mesostigmata: Macrochelidae)	
sp.	(Astigmata: ?)	

Ohauora: guano and debris under stones in gannetry, P/s sample 123 (cold funnel extraction).

Diponevra sp. nr. *caudata*	(Diptera: Phoridae)	(2)
sp.	(Astigmata:)	

Ohauora: low plants and grass above gannetry, P/s sample 124 (funnel extraction with top heat).

sp.	(Lithobiomorpha: Henicopidae)	(1)
sp. A	(Hemiptera: Aphididae)	(1 nymph)
sp.	(Diptera: Sciaridae)	(2)
Strumigenys perplexa	(Hymenoptera: Formicidae)	(1 worker)
Mymar pulchellum	(Hymenoptera: Mymaridae)	(1)
Hemiptarsenus sp.	(Hymenoptera: Eulophidae)	(1♂)
Melanophthalma sp.	(Coleoptera: Lathridiidae)	(1)
Coxelus spp.	(Coleoptera: Colydiidae)	
sp.	(Amphipoda: ?)	(2)
Austrochthonius inversus	(Pseudoscorpiones: Chthoniidae)	(1♂, 1 nymph)
sp.	(Araneae: Lycosidae)	(2)
Allonothrus n. sp.	(Cryptostigmata: Trhypochthoniidae)	
Austrocarabodes nodosus	(Cryptostigmata: Carabodidae)	
Globoppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 2	(Cryptostigmata: Oppiidae)	
Epicroseius n. sp.	(Mesostigmata: Liroaspidae)	
sp.	(Mesostigmata: Uropodidae)	
Cyrtolaelaps n. sp.	(Mesostigmata: Rhodacaridae)	

Ohauora: low plants and grass above gannetry, P/s sample 125 (cold funnel extraction).

sp. A	(Hemiptera: Aphididae)	(1 nymph)
Aptinothrips rufus	(Thysanoptera: Thripidae)	(4)
Proternia philocapna	(Lepidoptera: Pyralidae)	(1)
sp.	(Hymenoptera: Diaprididae)	(1♀)
spp.	(Coleoptera: Colydiidae)	(larvae)
sp.	(Mesostigmata: Uropodidae)	
Amblyseius sp.	(Mesostigmata: Phytoseiidae)	

Ohauora: under bark of rotting pohutukawa logs.

Euophryum rufum	(Coleoptera: Curculionidae)	(1)
? *Euophryum*	(Coleoptera: Curculionidae)	(2)
Euryolpium (Antiolpium) zealandiense	(Pseudoscorpiones: Olpiidae)	(5)

Ohauora: bark on rotting pohutukawa log, P/s sample 126 (funnel extraction with top heat).

Entomobrya sp. A	(Collembola: Entomobryidae)	(9)
Liposcelis sp. C	(Psocoptera: Liposcelidae)	(2)
sp.	(Psocoptera: Trogidae)	(1)
sp.	(Coleoptera: Ptiliidae)	(1)
Holoparamecus spp.	(Coleoptera: Merophysiidae)	
sp.	(Coleoptera: Colydiidae)	(2)
Pholcomma sp.	(Araneae: Theridiidae)	(1)
Ingella n. sp.	(Cryptostigmata: Oribatulidae)	
sp.	(Mesostigmata: Uropodidae)	
Lasioseius n. sp.	(Mesostigmata: Blattisociidae)	
Cosmolaelaps n. sp. 2	(Mesostigmata: Dermanyssidae)	

Ohauora: rotten pohutukawa log. P/s sample 127 (cold funnel extraction).

Diporochaeta obtusa	(Oligochaeta: Megascolecidae)	(2 aclitellate)
sp.	(Polydesmida: Dalodesmidae)	
sp.	(Geophilomorpha: Geophilidae)	(1)
sp.	(Lithobiomorpha: Henicopidae)	(2)
Pseudachorutes sp.	(Collembola: Neanuridae)	(4)
Neanura novaezealandiae	(Collembola: Neanuridae)	(5)
Parafolsomia sp.	(Collembola: Isotomidae)	(1)
Entomobrya sp. A	(Collembola: Entomobryidae)	(12)
Metriocampa sp.	(Diplura: Campodeidae)	(2)
sp.	(Diptera: Sciaridae)	(6)
sp.	(Diptera: Cecidomyiidae)	(1)
Antipodophora sp.	(Diptera: Phoridae)	(3)
sp.	(Hymenoptera: Ceraphronidae)	(1♂, 2♀♀)
Mesocolon nesobium	(Coleoptera: Anisotomidae)	
sp.	(Coleoptera: Staphylinidae)	(larvae)
Clambus sp.	(Coleoptera: Clambidae)	(1)
Holoparamecus spp.	(Coleoptera: Merophysiidae)	
spp.	(Coleoptera: Merophysiidae)	(larvae)
Europhryum rufum	(Coleoptera: Curculionidae)	(1)
sp.	(Amphipoda: ?)	(1)
Austrochthonius inversus	(Pseudoscorpiones: Chthoniidae)	(1 nymph)
Allonothrus n. sp.	(Cryptostigmata: Trhypochthoniidae)	
Austrocarabodes nodosus	(Cryptostigmata: Carabodidae)	
Holophorella n. sp.	(Cryptostigmata: Phthiracaridae)	
Anellozetes longicaulis	(Cryptostigmata: Mycobatidae)	
Pseudoceratoppia microsetosa	(Cryptostigmata: Metrioppiidae)	
Amerioppia n. sp.	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 2	(Cryptostigmata: Oppiidae)	
Ixodes eudyptidis	(Megastigmata: Ixodidae)	
Epicroseius n. sp.	(Mesostigmata: Liroaspidae)	
sp.	(Mesostigmata: Uropodidae)	
Cyrtolaelaps n. sp.	(Mesostigmata: Rhodacaridae)	
Cosmolaelaps n. sp. 2	(Mesostigmata: Dermanyssidae)	

Ohauora: pohutukawa forest, swept.

Peripsocus sp. ? *morulops*	(Psocoptera: Caeciliidae)	(1)
Scoparia sp.	(Lepidoptera: Pyralidae)	(1♂)
Phrissogonus testulatus	(Lepidoptera: Geometridae)	(1♀)
sp.	(Diptera: Mycetophilidae)	(1)
sp.	(Diptera: Sciaridae)	(2)
Tetrachaetus simplex	(Diptera: Dolichopodidae)	(5)
Lasiopleura wisei	(Diptera: Chloropidae)	(1)
Aranea sp.	(Araneae: Epeiridae)	(1)
Aranea pustulosa	(Araneae: Epeiridae)	(2)

Ohauora: pohutukawa forest, on pohutukawa.

sp.	(Hemiptera: Cicadidae)	
Trioza curta	(Hemiptera: Psyllidae)	(1♂, 13 nymphs)
sp.	(Hemiptera: Pseudococcidae)	(1)
Eriococcus sp.	(Hemiptera: Eriococcidae)	(1♂, several ♂ tests)

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 130 (funnel extraction with top heat).

sp.	(Lithobiomorpha: Henicopidae)	(1)
sp.	(Coleoptera: Staphylinidae)	(larvae)
sp.	(Amphipoda: ?)	(1)
Globoppia n. sp. 1	(Cryptostigmata: Oppiidae)	

Ohauora: wet pohutukawa leaf litter at top of forest, P/s sample 131 (cold funnel extraction).

sp.	(Polydesmida: Dalodesmidae)	
sp.	(Lithobiomorpha: Henicopidae)	(2)
Gnatholonche sensilla	(Collembola: Neanuridae)	(1)
Pseudachorutes sp.	(Collembola: Neanuridae)	(4)
Hypogastrura rossi	(Collembola: Hypogastruridae)	(4)
Proisotoma sp.	(Collembola: Isotomidae)	(1)
? *Isotoma* sp.	(Collembola: Isotomidae)	(1)
Entomobrya sp. A	(Collembola: Entomobryidae)	(3)
Entomobrya sp. B	(Collembola: Entomobryidae)	(4)
Sminthurinus granulatus	(Collembola: Sminthuridae)	(4)
sp.	(Hemiptera: Pseudococcidae)	(2)
sp.	(Diptera: Psychodidae)	(3)
sp.	(Diptera: Sciaridae)	(17)
sp.	(Diptera: Cecidomyiidae)	(10)
Amblyopone saundersi	(Hymenoptera: Formicidae)	(1 queen)
Camptoptera sp.	(Hymenoptera: Mymaridae)	(1♂)
sp.	(Hymenoptera: Ceraphronidae)	(1♂)
Nemaglossa atriceps	(Coleoptera: Carabidae)	
Mecyclothorax rotundicollis	(Coleoptera: Carabidae)	(1)
spp.	(Coleoptera: Carabidae)	(larvae)
sp.	(Coleoptera: Staphylinidae)	(larvae)
Holoparamecus spp.	(Coleoptera: Merophysiidae)	
spp.	(Coleoptera: Merophysiidae)	(larvae)
Lathridius spp.	(Coleoptera: Lathridiidae)	(1)
Melanophthalma sp.	(Coleoptera: Lathridiidae)	(1)
Coxelus spp.	(Coleoptera: Colydiidae)	(1)
Tenebrio obscurus	(Coleoptera: Tenebrionidae)	(1)
sp.	(Amphipoda: ?)	(2)
Austrochthonius inversus	(Pseudoscorpiones: Chthoniidae)	(5♂♂, 11♀♀, 8 nymphs)
sp.	(Araneae: Agalenidae)	(3)
Holophorella n. sp.	(Cryptostigmata: Phthiracaridae)	
Totobates ovalis	(Cryptostigmata: Oribatulidae)	
Scheloribates conjuges	(Cryptostigmata: Oribatulidae)	
Oppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 1	(Cryptostigmata: Oppiidae)	
Globoppia n. sp. 2	(Cryptostigmata: Oppiidae)	
Epicroseius n. sp.	(Mesostigmata: Liroaspidae)	
sp.	(Mesostigmata: Uropodidae)	
Digamasellus n. sp.	(Mesostigmata: Rhodacaridae)	
Cyrtolaelaps n. sp.	(Mesostigmata: Rhodacaridae)	
Ameroseius aff. *ornatus*	(Mesostigmata: Ameroseiidae)	
Pyemotes sp.	(Prostigmata: Pyemotidae)	

Ohauora: pohutukawa shrubland, under stones.

Euryolpium (*Antiolpium*) *zealandiense*	(Pseudoscorpiones: Olpiidae)	(2)

Ohauora: pohutukawa leaf litter in shrubland, P/s sample 128 (funnel extraction with top heat).

sp. A	(Araneae: Dictynidae)	(1)

Ohauora: pohutukawa leaf litter in shrubland, P/s sample 129 (cold funnel extraction).

sp.	(Hemiptera: Pseudococcidae)	(1)
Aptinothrips rufus	(Thysanoptera: Thripidae)	(1)
sp.	(Mesostigmata: Uropodidae)	

Crater rim.

Saprinus sp. aff. *pseudocyaneus*	(Coleoptera: Histeridae)	(1)
Coccinella undecimpunctata	(Coleoptera: Coccinellidae)	
sp.	(Araneae: Lycosidae)	(1)

DISCUSSION

General indications, from specialists and from personal knowledge of the author, are that the White Island fauna is derived from the New Zealand mainland. As there is a west-wind drift over New Zealand, this is to be expected. Although some of the White Island specimens belong to undescribed species, this is probably because of insufficient knowledge of mainland faunas or, as is known for other off-shore islands, the island is a refuge for species now rare on, or absent from, the mainland. Only a very small area of the island was examined for a brief period and it is expected that the fauna contains many more terrestrial invertebrate species than the 162 listed here. A marine littoral caddis-fly and a supra-littoral mosquito have been retained in the above lists, as they belong to essentially terrestrial groups.

From direct observation, two occurrences are most interesting. The only non-flying insect found to penetrate the crater valley, beyond the shore line, was an immature earwig. This may have been living on wind-blown debris. At Ohauora, pseudoscorpions were found, together with remains of beetles, under stones in the pohutukawa shrubland. The pseudoscorpions may be the dominant animals of this zone, living on stray or wind-blown insects from the adjacent forest, although it is possible that they share this food supply with scavenging or predatory beetles.

The 18 Plant/soil samples, taken on the island, yielded most of the specimens recorded here. In some cases, e.g., samples 130, 131, the difference between the two extraction methods is marked and the top-heat extraction has removed only the most mobile forms, as expected. However, in others, e.g., samples 118, 119, this has not happened to such a marked degree, and in some, e.g., samples 124, 125, the cold funnel has extracted fewer species although some are different from those taken per the top-heated funnel. It appears, in fact, that the two extraction methods complement each other.

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